Attachment #94.4.7

Sanitary Survey

for

GREAT BAY AND LITTLE BAY NEW HAMPSHIRE

New Hampshire Department of Health and Human Services

Division of Public Health Services

Bureau of Food Protection

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TABLE OF CONTENTS

List of Tables

List of Figures

I. Executive Summary

Many improvements have been made in local wastewater treatment facilities, and best management practices at farms and other potential pollution sources have begun to become more prevalent since the previous sanitary survey was published in 1991. The results of the present sanitary survey suggest that new areas can be classified as approved, and the boundaries for other areas are now better defined. The new areas that could become classified as approved are in the northern portion of the growing area, from the present boundary in Little Bay between Adams Point and the cable crossing to a line from the tip of Fox Point to the northern shore of Durham Point, immediately south of the mouth of the Oyster River A thorough analysis of conditions and water quality in the whole growing area support classification of the area with no conditions, including all meteorological and hydrological conditions. The only exceptions to this are extreme meteorological events such as Hurricane Bob and other rare events that would cause unusual pollution to occur.

II. Description of Growing Area

A. Location map showing growing area

Figure 1 shows the boundaries of the growing area in question which includes the portion of Little Bay, extending south of the mouth of the Oyster River to Furber Strait and the entire Great Bay of southeastern New Hampshire. Boundary lines were drawn approximately 200 meters upstream from the mouths of the Lamprey, Squamscott and Winnicut Rivers. Each of these rivers and the Oyster River, are treated as point sources of pollution for the purpose of this study. The northern boundary line extends east from the southern shore of the mouth of the Oyster River on Durham Point to the western most tip of Fox Point in Newington for the purpose of this Sanitary Survey.

B. Description of area

The growing area lies within the Great Bay Estuarine System of southeastern New Hampshire. Specifically, the area proceeds southward from the mouth of the Oyster River to include a substantial portion of Little Bay, then further south through Furber Strait at Adams Point to include all of the Great Bay. The northern boundary is drawn eastward from the southern shore of the mouth of the Oyster River to the western most tip of Fox Point, while boundary lines southward exist at the mouths of the Lamprey, Squamscott and Winnicut Rivers. Water movement within the area is governed primarily by tidal currents while secondary influences are provided by the several tributaries that carry freshwater into the area. Beginning at the northern boundary and proceeding counterclockwise around the perimeter of the growing area, major tributaries in the area include the Oyster River, Crommet Creek, the Lamprey River, the Squamscott River and the Winnicut River. The Great Bay and part of Little Bay was designated by the United States Congress and the National Oceanic and Atmospheric Administration (NOAA) as a National Estuarine Research Reserve (NERR) in 1989 to promote long term research and public education in order to better manage and preserve the diversity of natural resources within this vital ecosystem. The Reserve includes 4400 acres of tidal waters and mudflats, with approximately 400 acres of protected lands through conservation easements.

Great Bay is a large, shallow embayment with an average depth of 2.7 m, with deeper channels extending to 17.7 m. Little Bay has an average depth of 3.4 m with areas of the central channel extending to 15.2 m. In the southern portion of Great Bay, two channels from the Lamprey and Squamscott Rivers in the southwest and a smaller, less well-defined channel in the southeast meet in the center of the Bay to form a central deep channel which extends northward through Great Bay to Adams Point. This channel carries tidal water into Little Bay. The tidal range of the growing area varies from 2.0 m at Dover Point, just east of the northern boundary, to 2.1 m at the mouth of the Squamscott River. The area is subject to strong tidal currents and vertical mixing, limiting the vertical stratification of waters throughout most of the year. During periods of excessive freshwater runoff, partial stratification of the water column can occur.

At low tide, approximately 50% of the Great Bay is exposed with most of the intertidal zone consisting of mudflat and macrophyte habitats. The shoreline of Little Bay is also dominated by large tidal mudflats. Extensive salt marshes exist along the upper intertidal zones at the mouths of the Squamscott, Lamprey and Winnicut Rivers and at Crommet Creek.

Several bivalve species can be found within the growing area including razor clams (*Ensis directus*), blue mussels (*Mytilus edulis*), ribbed mussels (*Geukensia demissus*) and more importantly, substantial amounts of American oysters, (*Crassostrea virginica*) and soft shell clams (*Mya arenaria*). American oyster populations are highest in Great Bay at Nannie Island southwest of Woodman Point. A smaller oyster bed can be found just south of Adams Point. In addition to these two major beds, scattered oysters can be found throughout Great and Little Bay. Together, these beds form a total area of twenty eight acres available for harvest. There are presently no major oyster beds in Little Bay. Soft shell clams are less prevalent, with the abundance in Little Bay estimated to be approximately 4 bushels per acre with a harvestable area of 430 acres. The total harvestable area of soft shell clams within Great Bay is more than double that of Little Bay, with a total of 1000 acres.

The shorelines of Little and Great Bay are a mix of residential property, some agricultural land and woodlands. Most of the land surrounding the watershed for the growing area is forested. Agricultural use of shoreline land within the growing area is minimal and sparse. Human population along the growing area is moderate, with concentrated areas along the northwestern shore of Little Bay in Durham, the southeastern shore of Great Bay in Greenland, particularly on Brackett and Weeks Points, and the eastern shore of Little Bay in Newington. These residences on Brackett and Weeks Points are predominantly summer camps which are seasonally occupied . Shoreline ownership around the growing area is typically private, with some lands protected or in government ownership. Acquisition of lands for conservation easements is an ongoing process, with both government and private programs in operation. Two Wildlife Sanctuaries/Habitats which fall under government jurisdiction border the growing area. One is a large protected area which lies on the Newington side of Little Bay, beginning at Welsh Cove and extending southward to Woodman Point, at the site of the former Pease Air Force Base. This natural preserve of 1054 acres, with approximately four miles of shoreline, has been designated as the Great Bay National Wildlife Refuge by the US Fish and Wildlife Service. Similarly, at Adams Point, between Little and Great Bays, there is an established Wildlife Management Area which is administered by the NH Fish and Game Department.

C. History of growing area classification

The last sanitary survey on this area was conducted by John Seiferth of the NH Division of Public Health Services in March 1991 based on research performed in September of 1990. Classification of this area was based on water quality data from 1988-1991 and 1990 shoreline reconnaissance work. Figure 2 shows that prohibited (a small portion of southwest Great Bay), restricted (Little Bay and some of southwest Great Bay) and approved (north and southeast Great Bay) classifications resulted from this survey. Since these classifications were designated, many efforts have been made throughout the estuary to improve water quality. Most of the wastewater treatment plants (WWTP) within the estuary have upgraded their facilities and received stricter permit requirements from the EPA and the NHDES regarding chlorination and total coliform counts in effluent. Farms within the growing area have begun to adopt Best Management Practices (BMP) in an attempt to reduce fecal contamination to surrounding waters.

III. Pollution Source Survey

A. Summary of Sources and Locations

1. Map or chart showing the location of major sources of pollution

Figure 3 shows the locations of potential pollution sources to the growing area. A discussion concerning each individual source follows in Section 2. The shoreline survey was conducted by boat at both low and high tide in August and September 1994 by Drs. Richard Langan and Stephen Jones and by foot in highly populated areas during April and May 1995 by Paul Raiche, Andrea Tomlinson and Deborah Lamson. By boat, properties were surveyed at high tide in order to gain close access to shore for better observation, while at low tide, any pipes located below the high water mark could be more readily observed. Homes bordering the growing area were evaluated by looking for malfunctioning septic systems, gray water pipes, outhouses and other potential pollution sources. During shoreline reconnaissance by foot, many land and cellar drains were discovered but none were determined as being potential pollution sources. One old, abandoned outhouse with a cement foundation was found on the northwest side of Great Bay and a suspected malfunctioning septic system was discovered in the same vicinity. Another potentially malfunctioning septic system was found on the east side of Little Bay in Newington. Both systems have been reported to the appropriate town and state officials (See Section IIII A. 2. for results). All major drainage streams (those with a flow of at least 15 gpm) were evaluated and water samples were taken from each of these major streams (see discussion in section III. A. 2.).

2. Table of pollution sources

Table 1 lists thirteen actual or potential pollution sources found either directly within the growing area or within tributaries which flow into the growing area (Figure 3). Included in Table 1 are "Relevant Sample Sites." These are specific water quality sampling sites that have been designated by both the Division of Public Health Services and the Jackson Estuarine Laboratory staff which will show the effects, if any, that each pollution source listed in Table 1 has on a specific section of the growing area. Figures 4 and 5 show the array of all sampling sites which have been established in order to monitor water quality throughout the growing area. Sites GB1-GB7 (JEL) were established by Jackson Estuarine Laboratory (JEL) based on past and ongoing studies to give a more comprehensive documentation of spacial and temporal water quality trends in the southwest portion of Great Bay (Figure 4). Sites GB4A-GB80 (DPHS) are sites established by DPHS to support the routine classification of the area (Figure 5). Listed below are sampling sites included in Figures 4 and 5 which were routine sample sites in the evaluation of water quality within the growing area for this study.

Sample site	Location
GB1 (JEL)	Off Adams Point, Little Bay
GB2 (JEL)	Center of northern Great Bay
GB3 (JEL)	Mid-center Great Bay
GB4 (JEL)	Southwest Great Bay
GB5 (JEL)	Mouth of Lamprey River
GB6 (JEL)	Mouth of Squamscott River
GB7 (JEL)	Chapman's Landing, Squamscott Rvr
GB4A (DPHS)	Same as JEL GB3
GB4B (DPHS)	Just east of GB4A
GB5 (DPHS)	Off Woodman Point, Great Bay
GB6 (DPHS)	Northeast Little Bay
GB7A (DPHS)	Southeast Little Bay
GB7B (DPHS)	Off Thomas Point, Great Bay
GB15 (DPHS)	Same as JEL GB5
GB16 (DPHS)	Off Pierce Point, Great Bay
GB19 (DPHS)	Off Fox Point, Little Bay
GB23 (DPHS)	South of Colony Cove, Little Bay
GB50 (DPHS)	Mouth of Oyster River, Little Bay
GB80 (DPHS)	Same as JEL GB6

Data for these sites are presented in Tables 2 and 3 and discussed in Sections IV, V and VI. All major and minor tributaries have been evaluated. The major tributaries, the Lamprey, Squamscott, Oyster and Winnicut Rivers are being treated as individual point sources of pollution. The results for water samples collected from sites 1S/A-15S (Figure 4), which were established as a result of shoreline survey work performed for the 1991 Sanitation Survey, are shown in Table 4. Fecal coliform concentrations were relatively low (<43/100 ml), except at sites CC, 14S and 15S on July 12, and site 5A on August 9. Sites CC and 5A had lower levels on different dates, and the geometric means for these sites were <43/100 ml. Sites 14S and 15S were sampled once, but these are located well into the mouth of the Squamscott River, and should be considered as part of this point source to the growing area.

Small tributaries that empty into the southeast corner of Great Bay were sampled in the summer of 1994. Figure 5 shows the small tributary sampling sites, G/N 1- G/N 11 (excluding G/N 8), and the analytical results are presented in Table 5. Brackett Brook (G/N 1) and the stream north of Great Bay Farm (G/N 7) had little contamination. The other tributaries had higher levels of bacterial contaminants, especially G/N 2 and Foss Brook (G/N 3 & 4), as described below and identified as PS 11 and PS 12, respectively. The other tributaries, Packer Brook (G/N 6), McIntyre Brook (G/N 10), the Winnicut River (G/N 11), and, to a lesser extent, Shaw Brook (G/N 5) and Pickering Brook (G/N 7), all contained elevated levels of fecal coliforms. However, none of these tributaries appear to have much impact on water quality in Great Bay, based on the results for the routine sample sites GB 5 and GB 16 (Table 3; see Section V).

Pollution sources listed in Table 1 and below which are located on the major river tributaries are considered to be either point or non-point sources *within* these tributaries. A brief explanation of each source and its potential to contaminate the growing area is given below.

PS 1, PS 2, PS 3- The Durham, Newmarket and Newfields wastewater treatment plants are potential pollution sources. The Exeter plant was not included as a potential source due to its location at least four miles from the growing area at the mouth of the Squamscott River. Performance standards for these plants have improved over the past five years. Unless an upset occurs at the plants themselves or at a pump station within any of the systems, these plants are considered to be potential, indirect pollution sources.

PS 4 - Little Bay Buffalo Farm has potential to contribute fecal contaminants to the growing area in the form of buffalo feces from the grazing fields. This contamination could reach the growing area as direct runoff or through natural drainage streams leading to the growing area from the farm. A sample from site 1A, located just off this farm, had little (6 FC/100 ml) contamination (Table 4). The grazing fields here are large and the buffalo are scattered throughout the property. Therefore, the likelihood of any centralized contamination is low.This is considered a nonpoint source, having an indirect impact on the growing area

PS 5 - Bittersweet Dairy Farm has potential to contaminate the Squamscott River with runoff containing cow feces from the grazing fields. Manure from the barns is stored at least one mile from the river and the grazing fields are well buffered by woodland. This is a nonpoint, indirect source contributing to the water quality of the Squamscott River as a point source of pollution to the overall growing area.

PS 6 - Stuart Farm has potential to contaminate the Squamscott River with runoff containing cow feces from hay, corn and grazing fields. The farm has a small solids collection dam, a constructed wetland and a one-way tidal gate in a detention pond as buffers between the farm and the river. The farm is also practicing *Best Management Practices,* as recommended by the NH Office of State Planning and the Natural Resources Conservation Service. This is a nonpoint, indirect source that may influence the water quality of the Squamscott River as a point source.

PS 7- Great Bay Farm is located on the shore of the growing area and has potential to contribute contaminants to southeast Great Bay in the form of runoff containing cow feces from the grazing pastures and runoff from the corn and hay fields. This is considered a nonpoint, indirect source of pollution to the growing area. Samples collected in the summer of 1994 from the Bay (10S, 11S, 11A; Table 4) and the brook on the north border of the farm (G/N 1; Table 5) revealed no significant contamination.

PS 8 - Beck Horse Farm has little potential for impact on the growing area. The farm has only fifteen horses with a barn setback at least 2000 feet from Great Bay. Potential pollution from the horse farm would come in the form of runoff containing horse feces. A sample from the Bay adjacent to this farm showed no contamination (8S; Table 4). This is a non-point, indirect source of pollution to the growing area.

PS 9 - A suspected malfunctioning septic system in Newmarket is a potential pollution source. This system appears to cause leaching of bacterial contaminants into a pond which empties into northwest Great Bay. Fecal coliform tests performed on water samples from the pond outfall on April 17 and May 31. These tests revealed counts of 1250/100ml on April 17 and 15,300/100ml on May 31. These counts suggest a septic system malfunction. This situation is in the process of being remedied through contact with the Newmarket Health Inspector and the NH Department of Environmental Services (DES) Subsurface Systems Complaints Division, both of whom have inspected the site. Appendix B contains a follow up letter received from the NH DES. This is a nonpoint, direct source of pollution to the growing area. However, water quality sampling sites in the vicinity of the pond do not validate this source as being a major contributor of fecal contamination to this area. On May 31, a sampling transect was set up beginning at the pond extending northward to Adams Point. Six sites were sampled along this transect and counts of fecal coliforms ranged from <1/100 ml at Adams Point to 27/100 ml 30m from the pond outfall. Other samples taken in the Bay (site 5B) near this site showed no significant contamination (Table 4). These data suggest that fecal contamination from the pond may enter Great Bay, but dilution of contaminants in the tidal water appears to minimize the impact to the growing area.

PS 10- The McNeill residence in Durham has four horses. Potential pollution from this site could come from runoff containing horse feces. Manure is collected and stored at least 400 feet from the shoreline. A natural drainage stream runs from the corral area to the growing area. Little contamination was observed at sites in the adjacent bay (site 1S; Table 4). This is a nonpoint, indirect pollution source to the growing area.

PS 11- Drainage stream G/N 2 located in the southeast corner of Great Bay had a geometric mean fecal coliform count of 790/100 ml for three sample dates (Table 5). The stream runs adjacent to Great Bay Road in Greenland. The contamination may be caused by septic system-impacted groundwater, runoff or wildlife. This is a nonpoint, direct possible pollution source to the growing area. Routine water scores (site GB16; Table 3) within this region indicate a high attenuation of the stream contaminants before they enter the growing area.

PS 12- Foss Brook (G/N 3 & 4) was also found to have elevated fecal coliforms. Levels at the downstream site (G/N 4) were at least 700/100 ml or higher on the three occasions in which it was sampled (Table 5). Figure 5 shows the location of the sampling site to be at Bayside Road, at least 300 feet from the point at which the stream enters the growing area. By the time the stream empties into the growing area, it is likely that much of the contamination will be diluted on the spot. Water quality scores at GB 16 support this (Table 5). Contaminants may reach Foss Brook from septic system-impacted groundwater, runoff or wildlife. This is a nonpoint, direct source of possible contamination to the growing area.

PS 13 - Malfunctioning septic system/gray water pipe in Newington. This septic system was built before NH started approving septic systems through the NH DES. The owner informed the shoreline survey team that the two visible 3" PVC pipes were connected to the septic tank and one to the leach field of the septic system. The same property also has a gray water pipe which discharges laundry water only onto the lawn and eventually some of can reaches the bay. Upon returning to this site to obtain a sample of each of these discharge pipes, no flow from any of the pipes could be detected. Samples of bay water adjacent to this site revealed no significant contamination (sites 13S, 13A; Table 4). This system remains under investigation.

B. Identification and evaluation of pollution sources

1. Domestic wastes

A. Septic systems

Towns abutting the growing area with residences on septic systems are Durham, Newmarket, Newfields, Stratham, Greenland and Newington. The most densely populated areas are Brackett and Weeks Points in Greenland and Durham Point in Durham. Seasonal cottages make up the bulk of the homes on the points in Greenland, while homes on Durham Point are year-round residences. Moderately populated areas are on the east shore of Little Bay in Newington and the west shore of Great Bay in Durham and Newmarket. Research was carried out at each town hall in order to obtain septic system information for each residence within 500 feet from shore (see Appendix A). When available, detailed information including soil type, leach field area and distance from shore for each individual septic system was obtained. Where this information was not available, the year the residence was built is given. Locations of homes are given by map and lot number for each town according to the town tax maps (also Appendix A). All homes within the growing area have individual septic systems with the exception of a few homes on Moody Point in Newmarket which are linked to the town's municipal sewer system (Figure 6). Soil suitability for septic tanks along the growing area shores varies. Land closest to shore is predominantly composed of marine clays and shale. Moving inland from shore, gravel and sand deposits over a base of metasedimentary hard rock predominate.

B. Wastewater treatment plants

There are several municipal wastewater treatment plants which discharge into the waters of the Great Bay Estuarine system, none of which discharge directly into the growing area (Figure 7). Those which may indirectly impact the growing area due to their location on tributaries associated with Great and Little Bays are described with a summary of operations as follows.

Durham WWTP: The Durham Wastewater Treatment Plant is located off Route 4, along the northern shore of the Oyster River in Durham. The plant is approximately two miles upstream from the mouth of the river where it meets Little Bay. The plant went on line in 1935 as a primary treatment facility and was upgraded to secondary treatment in 1981. The plant services 850 residences from the town of Durham and the entire University of New Hampshire (UNH). Serviced areas are all located west of the tidal dam in downtown Durham, north of the tidal portion of the Oyster River and west of the WWTP. Thus, all areas along the southern shore of the tidal portion of the Oyster River are serviced by septic systems, in addition to areas on the northern shore east of the WWTP (Figure 6). No industrial waste is processed through the plant. Wastewater is treated by grit removal, primary and secondary clarifiers, aeration tanks and then chlorination before discharge. All systems are duplicated. Dechlorination facilities are presently being installed with a projected completion date of late spring of 1995. Design flow at Durham is 2.5 MGD, average flow for 1994 was .98 MGD while peak flow reached 4.5 MGD in March 1994. Like all wastewater treatment facilities, Durham has some infiltration problems in wet weather which are continuously being abated. There are no CSO's within the municipal system.

The plant is alarmed for high water and power failure with both audio and visual alarms which connect to a dispatcher at UNH. A staff member is on 24-hour call to respond to the alarms. There is back-up power at the plant to prevent bypassing of wastewater. As a result, there have been no bypassing events in the last five years. There have been four different occasions where there was an overabundance of filamentous bacteria in the secondary clarifier which resulted in solids being discharged into the Oyster River. This occurred as a result of the overactive bacteria causing the solid waste matter to become buoyant, flow over the secondary clarifier weir, through the chlorine contact tank, and into the Oyster River. This particular problem occurred in February 1991, twice in February 1994 and once in February 1995. The plant operator has called in outside engineering experts to remedy this problem.

Four pump stations transport wastewater to the plant. All are alarmed for high water and power failure and all have back-up power. The main pump station is electronically alarmed and connected to the UNH dispatch. Notification of pump station malfunction follows that of plant malfunction, the person on call is contacted.

Effluent is chlorinated at 1-2 ppm just before discharge through two 24" outfall pipes into the nearshore area of the Oyster River where depth ranges from 1-4 feet at mean low tide. Interruptions within the chlorination system are rare. The total coliform limit for effluent is 70/100ml. The geometric mean for samples analyzed in 1994 was 14/100ml. Studies done on the Oyster River watershed further support the fact that the Durham WWTP had only rare impacts on the contamination levels found in this system (Jones and Langan, 1993, 1994). Compared to the fecal coliform loading produced by tributaries entering the Oyster River, it was found that the Durham outfall contributed only 0.17% of the total fecal coliform contamination within the river. Furthermore, upon sampling all major tributaries which enter Oyster River, it was discovered that the Durham outfall had the lowest fecal coliform counts when compared to scores found at other sites within the watershed, probably due to the disinfecting nature of the residual chlorine in the effluent. Sludge is stored and composted on site in closed containers at least 800 feet from shore. Septage pumped from private septic systems is taken only from Durham .

Major upgrades occurred at the Durham plant between 1992 and 1993. They included installation of three new diffusors, replacement of dewatering equipment, aerators and sludge tank covers, wood ash introduced as composting material, new primary and secondary pumps as well as grinders, new effluent flowmeters with ultrasonic sensors and finally, electronic controls at two pump stations. In addition, as mentioned above, dechlorination facilities are in the process of being installed at this time. As previously mentioned, there have been four documented malfunctions at the Durham plant in the past five years involving buoyant solids overflowing from the secondary clarifier, through the chlorine contact tank and into the Oyster River.

Newmarket WWTP: The Newmarket Wastewater Treatment Facility is located off Route 152 along the Lamprey River in Newmarket. The facility is located approximately 1.75 miles from the mouth of the Lamprey River where it meets the Great Bay. The plant has been serving the community of Newmarket exclusively since construction in 1969, with a current usage of 1200 residences. Wastewater entering the plant is almost entirely domestic, with the exception of 55 GPD of noncontact cooling water waste from a local electronics manufacturer. The plant was upgraded to secondary treatment in 1986. Wastewater is treated by means of primary and secondary clarifiers, trickling filters and chlorination/dechlorination. Design flow is 0.87 MGD, average flow for 1994 was 0.61 MGD while peak flow for 1994 was 2.5 MGD. Infiltration is a problem in wet weather and pipes get constant attention in an attempt to remedy this common problem. There are no CSO's in the system. The plant is alarmed for high water and power failure by means of electronic alarms and back up power is available. Plant personnel are on a rotating, 24 hour on-call basis in order to deal with malfunctions. Wastewater is not able to bypass the plant, however, unchlorinated effluent has been discharged in the past due to a failure in the water supply to the plant. This occurred in October 1993. Five pump stations transport wastewater to the processing area. All are electronically alarmed for high water and power failure. Back-up power is present and provided by the main plant. Problems in the past with the electrical line carrying the back-up power to the pump stations have resulted in some overflowing at the main pump station adjacent to the Lamprey River on Creighton Street. This has occurred three times in the past five years, first in August 1991, then again in April 1992 and sometime in 1993. Another trouble spot during extreme wet weather has been a manhole at Joyce's Kitchen in downtown Newmarket. On days with exceptionally heavy rains, the manhole has burst, sending untreated wastewater into the adjacent Lamprey River. On one occasion in March 1993 during heavy rains, both the manhole at Joyce's and the pump station on Cedar Street overflowed. Malfunctions with pump stations are handled the same way as those with the plant, where the on-call staff member is contacted by the dispatch. Effluent is treated by means of flow paced chlorination/dechlorination to achieve a final chlorine residual close to 0 ppm. Chlorination contact tanks are duplicated. The outfall pipe is 15" in diameter and discharges into the Lamprey River at a point where the pipe is exposed at mean low tide but completely submerged at high tide. The permit limit for total coliforms in the final effluent is 70/100ml. The geometric mean for total coliforms in 1994 samples was 17/100ml. Sludge is dried and dewatered on site and stored in closed containers until it is taken to the Newmarket landfill. Recent upgrades which have occurred were the installation of a dewatering system and a dechlorination system in 1993. As mentioned above, there have been four documented malfunctions either at the Newmarket plant or at one of the pump stations within the last five years.

Newfields WWTP: The Newfields Wastewater Treatment Facility is located off Route 85 on the Squamscott River in Newfields. The plant is approximately 2.5 miles from the mouth of the river where it enters into the southwest portion of Great Bay. The facility has been on line since 1983 serving the community of Newfields only, with a present day total of 157 residences and three minor industries hooked into the system. Pretreated industrial waste comes from Kingston-Warren, a manufacturing company specializing in window moldings and metal shelving. The two remaining industries are screenprinting companies which have just moved to the Newfields area. Due to the recent relocation of these two screenprinting companies to Newfields, their industrial operations are still being reviewed by the town of Newfields and pretreatment requirements of screenprinting waste are pending. The Newfields facility treats wastewater by means of a three-part lagoon system which acts as secondary treatment. Influent is first treated with grit removal, then aerated in lagoons and finally chlorinated and discharged. Occasionally, there will be days when discharge does not occur and wastewater is simply stored in the lagoons. Design flow for the plant is 0.117 MGD, average flow for 1994 was 0.042 MGD while peak flow was 0.243 MGD in 1994. There are no CSO's within the system and minor infiltration problems in wet weather.

The plant is alarmed for power failure by means of an electronic telephone connected to a dispatcher. Back-up power is available. Due to the size of the three-part lagoon system, an alarm for high water is considered unnecessary and there is no possibility for wastewater to bypass the plant. If a malfunction should occur, the on-call employee would be immediately notified by the dispatcher. Two pump stations carry wastewater to the lagoons. Both are alarmed for high water and power failure and both have back-up power. Pump stations are equipped with both dry and wet wells, and bypassing throughout the system would occur via a manhole before a pump station. Malfunctions at pump stations are handled in the same manner as those with the plant.

The effluent is chlorinated at a concentration of ≥2ppm just after the third lagoon. Chlorination contact tanks are duplicated. Required installation of dechlorination facilities is currently pending on the permit from NH DES which is up for renewal this year. The total coliform limit for effluent is the standard 70/100ml. The geometric mean for TC in 1994 samples was <24/100ml. The outfall pipe is located in the Squamscott River where mean low tide depth is 3 feet. Discharge occurs on the outgoing tide twice per day. There is no ongoing treatment of sludge for lagoon systems, which is stored on the bottom of the lagoons and pumped every 15-20 years. There have been no recent renovations to the system and no documented upsets within the past five years.

Exeter WWTP: The Exeter Wastewater Treatment Facility is located on Newfields Road along the upper Squamscott River, just south of the Route 101 bridge in Exeter. This plant has a low potential for impact on the growing area due to its location at least 4 miles upstream from the mouth of the river. The lagoon-style system was constructed and on-line in 1990. Prior to this, the system was a series of stabilization ponds providing primary treatment and was upgraded in 1990 to provide adequate treatment of wastewater entering the system. Exeter residents, GTE of Exeter and the Exeter Hospital are all served by the plant. A total of 3300 domestic units are connected to the system. Like Newfields, the Exeter facility utilizes three aerated lagoon systems with chlorination/dechlorination to achieve secondary treatment. Design flow for the plant is 3.0 MGD, average flow for 1994 was 1.6 MGD while peak flow reached 6.2 MGD. All CSO's were separated from the system in 1992, except one at the main pump station. Like all sewer lines, there is some minor infiltration with wet weather.

The plant is alarmed for power failure with an electronic alarm system which signals a dispatcher. Notification procedures in case of plant malfunction consist of the dispatcher calling the plant operator who is on-call at the time of the malfunction. There are no alarms for high water due to the 75 million gallon holding capacity of the three lagoons. Similarly, wastewater is unable to bypass the plant due to the the holding capacity of the lagoons . Nine pump stations transport wastewater to the lagoons. The main pump station, located on Swazey Parkway in Exeter, contains a CSO, which is activated in heavy rains, draining into the Squamscott River. Pump stations are alarmed for high water and power failure and all are equipped with back-up power.

Notification of malfunctions with pump stations are reported in the same manner as those which occur at the plant.

Effluent is chlorinated/dechlorinated to achieve a final chlorine residual of close to 0 ppm. The total coliform limit in the effluent is 70/100ml. The geometric mean for 1994 samples was 13/100 ml, however, there were a total of twenty daily violations in 1994 ranging from 75 to 520 TC/100ml. The problem is thought to originate in the dechlorination system, where there is a possible leak in the lines, contaminating the effluent before it is discharged. This is an ongoing concern for the chief operator and is in the process of being remedied. The outfall pipe is 30" in diameter and is located along the Squamscott River, unsubmerged above the tide line. Sludge is stored on the bottom of the lagoons, which are pumped every 20 years. Bottom feeding catfish are kept in the lagoons to control sludge build up. There have been no major upgrades at the plant since 1990, and there have been no major upsets or documented malfunctions at the plant in the past five years.

It should be noted that the term "bypass", as mentioned above in all of the WWTP summaries, is defined as "an intentional diversion of a wastestream from a treatment facility ". An example of this would be a gate in a clarifier or a pump station pipe which can be opened in the event of heavy flow to release untreated wastewater. Bypassing is legal in New Hampshire if and only if the event is unavoidable to prevent property damage, personal injury and if there are no other feasible alternatives to prevent untreated wastewater from entering a water body. A bypass differs from an overflow or the discharge of unchlorinated wastewater (PC Stephanie Larson, NH DES). All malfunctions or bypasses which result in untreated wastewater entering a water body must be reported to NH DES within 24 hours of the occurrence. This is a stipulation in all of the above WWTP permits.

2. Marinas

There are no marinas located within the growing area. There are, however, several public boat launches which boaters may use to access the growing area. Those used most frequently are the Newmarket Public Launch on the Lamprey River, the Chapman's Landing Launch on the Squamscott River, the Adams Point Launch on Little Bay and the Durham Public Launch on the Oyster River. Boat traffic within the growing area is minimal from September-May but moderate in the summer months. Due to the shallowness and poor channel markings in the growing area, most leisure boating is done elsewhere within the estuary. There are no known live-aboard boats within the growing area. Several small boats are moored in the south and southeast sections of Great Bay during summer months. In addition, there are twelve moorings in southern Little Bay in the summer. All boats which use moorings are small, the majority of which have no on-board head. The above mentioned mooring sites are all located in deep water areas with substantial daily flushing.

3. Stormwater

Stormwater enters the growing area directly through various streams and brooks throughout each bordering town. Figure 8 gives a detailed view of the major drainage streams entering into the growing area. There are no combined sewer overflows (CSO's) in the growing area. Figure 8 shows two drainage streams in Newington labelled 002 and 003. These are permitted NPDES outfalls formerly used by Pease Air Force Base, presently used by the Pease International Tradeport. Ditch 002, or Flagstone Brook flows north from the site and eventually discharges into the northern, downstream portion of Little Bay not included in the growing area. Ditch 003, McIntyre Brook, flows from the runway into Great Bay just south of Fabyan Point. Both brooks are used for disposal of "stormwater runoff from airport activities" according to the NPDES/EPA- issued permit. Activities resulting in the production of this waste include aircraft maintenance, aircraft fueling, painting and stripping, aircraft washing and most significantly, aircraft deicing. McIntyre Brook has the potential for having a more direct impact on the growing area than Flagstone due to the location of the discharge. Major effluent characteristics which require monthly monitoring in McIntyre Brook include pH, oil and grease, primary deicing chemical (propylene glycol), surfactants, trichloroethylene (quarterly), and total recoverable iron and zinc. Most of the runway and aircraft parking apron, industrial shop area and the entire flightline area drain into McIntyre Brook. An oil/water separator is located near the origin of McIntyre Brook and a newly installed separator is located on Flagstone Brook. One of the main concerns with McIntyre Brook has been the propylene glycol content in the discharged water. This product is used in deicing aircraft and can potentially decrease the amount of dissolved oxygen in water.

In 1992, as a part of the Air Force Installation Restoration program, shellfish tissue analysis was performed on samples collected in the vicinity of the Air Force Base. In an effort to evaluate the potential impacts of contaminants released from the Air Force Base into McIntyre Brook, American oysters, softshell clams, ribbed mussels and mummichogs were collected at the mouth of the brook where it discharges into Great Bay. Results of these analyses concluded that aluminum, arsenic and potassium concentrations in shellfish tissue samples exceeded background concentrations . However, the presence of these metals at the concentrations in which they were detected did not indicate a significant health risk to humans, and the contaminants in McIntyre Brook were not considered by the NH DES as potential health risks (PAFB- Installation and Restoration Program). Other heavy metals analyses have been performed on shellfish tissue in Great Bay in the past, most recently in 1992. Listed below are results from these tests with detectable concentrations (ppm) listed for arsenic, cadmium, nickel, chromium, lead and mercury. The FDA "edible portion" limits (ppm) are also listed. It is evident from the listed concentrations that there is no risk of heavy metal contamination resulting from the Pease International Tradeport industrial activities.

Station	As	Cd	Ni	Cr	Pb	Hg
Thomas Point (1) Oyster tissue	5.80*	3.50	2.70	3.10	1.10	0.07
Nannie Island (1) Oyster tissue	8.80	3.70	4.10	3.80	1.30	0.17
Nannie Island (2) Mussel tissue	NA*	0.33	0.58	1.20	1.30	NA
FDA Guideline Edible portion	**NA**	**25.0**	**533.0**	**87.0**	**11.5**	**1.0**

* All concentrations in ppm dry weight
**NA-not available
(1) USEPA/NCCOSC (1994)
(2) Isaza et al. (1989)

In addition to McIntyre and Flagstone Brooks, there are two non-permitted drainage brooks located on the Pease International Tradeport property which drain into the southeast portion of Great Bay on both sides of McIntyre Brook. They are Peverly Brook and Pickering Brook (Figure 8). Runoff is characterized predominantly by overland flow to these streams. The Pease International Tradeport has adopted a *Stormwater Best Management Practices Plan* in order to properly handle all stormwater waste originating at the facility.

4. Agricultural waste

Agricultural use of land within the growing area has greatly declined during the past fifty years. At present, there are two small horse farms, one dairy farm and one buffalo farm located along the shoreline of the growing area. Other cow farms (both dairy and beef) outside of the growing area are located upstream on the Squamscott River in Stratham (see Figure 3, Pollution Sources). Listed below are brief summaries of activities on these various farms and site numbers which can be cross referenced to Figure 3. Information was obtained through personal communications with farm owner/operators.

Langley-Little Bay Buffalo Farm/PS4
247 Durham Point Rd.
Durham, NH

This is a fifty six acre buffalo farm with twenty nine buffalo and one horse located at the northern boundary of the growing area. Animals cannot enter the water and the closest the pasture area gets to the water is about 15 meters. A fence separates the grazing area from the water. Hay is grown on the property with occasional manure spreading.

Bittersweet Dairy Farm/PS5
Portsmouth Ave.
Stratham, NH

This is a three hundred acre farm with 125 cows and two pigs located on the lower Squamscott River outside of the growing area. Animals cannot enter the water and the entire pasture is fenced off. Manure storage is approximately one mile from the Squamscott River. The pasture is buffered by woodland. Pesticide and fertilizer are used on the fields.

Stuart Farm/PS6
John Merrill
Portsmouth Ave.
Stratham, NH

This is a dairy farm with 100-200 cows located on the lower Squamscott River outside of the actual growing area. Cows cannot enter the water directly. Manure storage is located within a picket dam behind the barn. There is a 600 m drainage ditch for the milkhouse wastes and runoff from the manure storage which goes to a pond with a tidal gate, through saltmarsh and then discharged into the Squamscott River. In 1993, the Natural Resources Conservation Service supported construction of a small solids collection dam and a constructed wetland upstream on the ditch close to the manure storage area. The farm is under *Best Management Practices* classification as assigned by the NH Office of State Planning. Manure is applied to hay and corn fields at rate of 10 tons/acre and 20-25 tons/acre, respectively. There is minimal field application of manure near the drainage ditch.

Great Bay Farm/PS7
Cynthia and Allen Smith
125 Newington Rd.
Greenland, NH

This is a two hundred thirty nine acre dairy farm with 200 cows, two horses and a pony, located on southeast side of Great Bay. Cows cannot enter the water directly. Manure is stored behind the barn, approximately 1000 meters from the bay. Manure is applied to the hay fields bordering Great Bay at a rate of 10 tons/acre and corn fields from 20-25 tons/acre twice per year. Both fields are buffered by at least 100 feet of woodland. A manure storage system has been installed to cut down on runoff contamination from the barn. The farm is under *Best Management Practices (BMP)* classification as assigned by the NH Office of State Planning.

Beck Horse Farm/PS8
Franklin Beck
632 Bayside Rd.
Greenland, NH

This property consists of eighty four acres and fifteen horses used for trail rides, just east of Weeks Point in the southeast portion of Great Bay. Animals have access to the water but do not enter the bay water directly. Manure is stored and spread on hay fields throughout the year. Natural drainage occurs via brooks and streams.

Spinney Beef Farm/PS9
241 Fox Point Rd.
Newington, NH

This is a forty-two acre farm with thirteen beef cows located on Broad Cove, east of the northern boundary of growing area. Manure storage area is approximately 400 meters from a tributary to Pickering Brook. Cows enter this brook on occasion. Manure is spread once a year on the hay fields.

McNeill Horses/PS 10
44 Colony Cove Rd.
Durham, NH

Less than half an acre area with four horses only, located on Durham Point at the northern boundary of the growing area. Horses are primarily kept in the barn and occasionally ridden in a fenced in area about 15 meters from shore. The horses cannot enter the water. Manure is collected and transported daily to a storage area 130 meters from shoreline. Some natural drainage occurs from the riding area into Little Bay. No fertilizers or pesticides are used on the land.

All of the above mentioned farms are practicing responsible management procedures to prevent manure from contaminating the respective bordering water bodies. Nonetheless, runoff from these farms, especially in spring time, may contribute to nonpoint source pollution within the growing area or to tributaries entering the growing area.

5. Wildlife areas

There are two wildlife preserves within the growing area. One is located in Newington at the site of the former Pease Air Force Base. It consists of a 1054 acre area bordering Little and Great Bay which has been designated as a Wildlife Sanctuary by the National Fish and Wildlife Service. The other preserve is located at Adams Point and administered by the NH Fish and Game Department as a Wildlife Management Area.

Mammals living within the growing area include whitetail deer, beaver, red fox, mink, otter, muskrat, coyote and raccoon. In addition, Great Bay is part of the Atlantic flyway and an important migratory stopover as well as wintering area for many waterfowl and wading birds. As a result, there are substantial populations of both seasonal and year round waterfowl throughout the growing area. Common species include cormorants, swans, Canadian geese, bald eagles, sea gulls, terns, ducks, herons, snowy egrets, common loons, and a large variety of perching birds. Waterfowl populations undoubtedly have a direct affect on water quality throughout the growing area.

6. Industrial waste

There are no major industrial activities on the shores of Great Bay or Little Bay with the exception of the Pease International Tradeport. Possible impacts of Pease are mentioned in the Stormwater section of this report. Small scale, light manufacturing is practiced along the Lamprey River in Newmarket and along the Squamscott/Exeter River in Exeter and Newfields, well outside of the growing area.

IV. Hydrographic and Meteorological Characteristics

A. Tides: Type and amplitude

Little and Great Bay experience diurnal tides. Mean tidal range varies from 2.0 m at Dover Point, just east of the northern boundary, to 2.1 m at the mouth of the Squamscott River at the southwest end of the growing area. Water volume within the entire estuary is 166×10^6 m^3 at low tide, increasing to 230×10^6 m^3 at high tide. Specifically, the water surface of Great Bay covers 11 km^2 at mean low tide, increasing to 23 km^2 of water surface area covered at mean high tide. Freshwater input to the growing area comes mainly from the Lamprey, Squamscott, and Winnicut Rivers in the south, and the Oyster River in the north. River flows vary seasonally, the greatest volumes occurring at times of spring runoff. Although freshwater input into the growing area is prevalent, tidal currents regulate overall current direction more than density-driven circulation patterns. Total freshwater input into the estuary represents an average 2% of the tidal prism volume, increasing slightly under wet weather and snowmelt conditions. Tidal current turbulence produces a vertically well mixed water column within the two bays. Distinctive mixing zones resulting from inputs from the east and west sides of Great Bay and the convergence of the Squamscott and Lamprey Rivers that occurs between JEL sites GB2 and GB4, respectively (see Figure 4). Partial stratification may occur during periods of intense freshwater runoff, especially at the upper tidal reaches of the tributaries entering the area. Generally, ebb currents are faster than flood currents, particularly in areas with restricted cross sectional areas such as Furber Strait. Figure 9 gives a detailed account of mid-ebb circulation patterns in the growing area. Within the growing area, currents tend to flow into the main channel on both ebb and flood tides. At Furber Strait, current speeds average up to 1.0 m/sec whereas average current speeds range between 0.5-0.6 m/sec in Great Bay and 0.75 m/sec in Little Bay. The strongest currents within a tidal cycle tend to be concentrated in a central core in the flow, especially in restricted sites such as Furber Strait. In other lower, narrower portions of the growing area, an overall increase in tidal amplitude and energy dissipation can be observed.

Flushing time for Great and Little Bay ranges between 18 and 26 days or 36-52 tidal cycles. Contamination to the growing area would be well diluted within this time and dispersed due to the freshwater inputs and strong tidal driven currents into the system.

B. Rainfall: Amounts, seasonality and frequency of significant rainfalls

Listed below are monthly and yearly total inches of rainfall from January, 1992 to June, 1995. Rain gauge measurements from Durham, NH, were obtained from Dr. Barry Keim and Robert Adams, the present and former NH State Climatologists. The frequency of rainfall events >0.5"/48 h are noted in parentheses.

	1992	1993	1994	1995
January	NA*	1.62(1)	4.88(5)	4.45(4)
February	NA	2.77(3)	1.60(1)	2.76(3)
March	NA	4.63(3)	5.46(4)	1.87(1)
April	NA	4.80(7)	2.76(2)	1.85(1)
May	NA	0.73(0)	4.02(4)	2.74(3)
June	NA	2.44(1)	1.73(1)	
July	4.11(4)	1.49(1)	2.20(1)	
August	3.58(3)	2.21(3)	4.05(3)	
September	2.74(4)	4.19(5)	7.26(3)	
October	3.39(2)	3.08(3)	0.19(0)	
November	5.20(4)	3.81(4)	2.88(2)	
December	2.45(3)	5.58(3)	5.55(3)	
Yearly total	21.47(20)	37.35(34)	42.61(29)	15.59(13)
Yearly mean	3.58 (3.3)	3.11 (2.8)	3.55 (2.4)	2.67 (2.2)

*NA= Not Available

Overall, the mean monthly rainfall is 3.25", with an average of 2.7 rainfall events/month that were >0.5"/48 h. Monthly precipitation ranged from 0.19 to 7.26 inches, both values for consecutive months (November and October) in 1994. There were a total of 96 1-2 day rainfall events with >0.5" rain within 48 h periods. These events were relatively evenly distributed during the months when shellfish could be harvested (September-June). The sampling conducted for water quality monitoring by DPHS and auxiliary sampling by JEL included 19 of these 96 events.

C. Winds

Winds affecting the growing area tend to come from the north and northwest in the fall and winter months and from the southwest during spring and summer months. Northeasterly winds are typical of storms. Wind-driven waves can greatly affect current direction and speed, especially in the shallower areas of Great Bay. Northeast winds tend to restrict ebb currents, holding water in the bays, while southwest winds restrict flood currents from flowing into the growing area. Wind waves that influence the bottom can resuspend sediments, increasing turbidity levels and particle-associated contaminants above those produced by regular tidal currents alone. Wind waves may also influence grain-size distributions and sediment transport within the growing area. Current velocities at the sediment surface can become greater than tidal current velocities as a result of wind waves, especially in the shallower areas of the growing area where overall tidal current strength tends to be low. In general, the effects of tidal currents throughout the bays may at times be significantly modified by wind-driven currents.

D. River Discharges: Volumes and seasonality

Major tributaries entering into the growing area are the Lamprey, Oyster and Squamscott Rivers. Listed below are river discharge data in cubic feet per second (cfs) for those three rivers obtained from the US Geological Survey Water Data Reports for water years (October-September) 1992 and 1993.

<u>Oyster River</u> 78km^2 drainage area

Annual mean discharge 16.8 cfs (1992)
18.5 cfs (1993)

<u>Lamprey River</u> 543 km^2 drainage area

Annual mean discharge 258 cfs (1992)
267 cfs (1993)

<u>Squamscott River</u> 331 km^2 drainage area

Annual mean discharge 163 cfs * (1991)

*At present, there is no gauge located on the Squamscott River. The annual mean here is an estimated value based on regression of mean discharge data from Lamprey, Oyster and Salmon Falls Rivers.

E. Actual or potential effects of transport on pollution to the harvest area

Nonpoint source pollution is the major source of fecal contamination to the classified area, as there are no point sources within the area. Nonpoint source pollution enters the area as either urban runoff, groundwater seepage from on-site septic systems, wildlife, boats, agricultural runoff, or as the result of shoreline development. Stream flow from tributaries entering the estuary carries 50% of the annual precipitation to the area. This less saline water is well mixed within the water column and diluted upon entering the respective bays. The impact of one storm event (1.08" rain in 48 h) in September, 1994 on FC concentrations in the classified area is shown in Table 6. FC values remained low (<14 FC/100 ml) over the three day period from GB6 (DPHS) down to GB5 (DPHS). FC levels were slightly higher at GB2 (JEL) the first day, then were <14/100 ml the next two days. At GB 4B, FC levels were high the first day and much lower the next two days. These data suggest that rainfall-associated contaminants can enter the classified area from the tributaries, but are rapidly attenuated in the channels leading into the approved area.

Transport of fecal-borne contaminants associated with freshwater in tributaries is dictated to a large extent by tidal mixing. Tidal currents act to disperse contaminants within the growing area by providing a well mixed water column. Since the growing area is subject to daily tidal influence, contaminants are continuously being flushed from the system on outgoing tides. With each incoming tide, a volume almost equal to that present at low tide returns to Great Bay, producing significant dilution of contaminants already present. This water returning to the growing area on an incoming tide will contain some of the same contaminants which were carried out with the ebb tide, but they will be more diluted and dispersed as a result of travel through the estuary. Furthermore, contaminant travel throughout the growing area is confined to the main channels with limited lateral flow and dispersion to shoreline areas. A comparison of more recent (July, 1993 to June, 1995) FC values at four sites (see Figure 4) along a transect from Adams Point into the Squamscott River for paired high and low tide samples is illustrated in Table 7. Geometric mean values for three of the sites (GB2, 4, 7) were significantly higher at low tide than at high tide. This suggests that these sites are significantly affected by the freshwater-associated contaminants most prevalent at low tide. At GB1, the geometric mean was higher at high tide than at low tide, but the difference was not significant. Other studies at JEL have suggested that the flow of water across the shallows of Great Bay at low tide, especially between GB2 and GB4, has a cleansing effect. This is caused by flocculation and settling of particulate and colloidal materials, with attached bacterial contaminants, when less saline water from the Lamprey and Squamscott rivers mixes with the more saline waters in Great Bay. Thus, tidal currents and mixing have a generally beneficial, cleansing effect on the water overlying the shellfish in the classified area.

V. Water Quality Studies

A. Map of sampling stations

Figure 5 shows the sites established by the NH Division of Public Health Services in order monitor the water quality of the growing area. Several sampling sites have been added to the area since the last survey was performed in 1991. They are: GB 16, which was added to give a better representation of water quality in the southeast portion of the Great Bay; GB 4B, which together with GB 4A and GB 5 reflect water quality conditions in the central part of Great Bay; GB 7A and GB 7B, which monitor the southernmost area of Little Bay and the northernmost area of Great Bay respectively; GB 23 and GB 19 which reflect water column conditions in northeast and north central Little Bay respectively. These additional sampling sites sampling give a much more comprehensive view of water quality throughout Little and Great Bays.

B. Sampling plan justification

Systematic random sampling was used to obtain all water samples. Samples were therefore obtained under both normal and adverse conditions for the past two years. Numerous water quality monitoring programs performed by researchers at Jackson Estuarine Lab have indicated that that fecal coliform concentrations may increase in the tributaries to Great and Little Bays under adverse conditions such as high rainfall and storms, however, no consistent trend has been observed for sampling sites within the growing areas (Tables 2 and 3; also see Section VI). Other water quality studies performed at JEL have shown that there is little difference between fecal coliform counts within the growing area at high and low tide.

C. Sample data analysis

The database for sampling sites relevant to the survey area are presented in Table 3. Included in the table are the coliform concentrations/100 ml for each station and sampling date, the number of samples collected and the 90th percentile score. The site numbers may be cross referenced with Figure 10 for exact geographic location. The results of the data analysis indicate that sites GB 4A, GB 4B, GB 5, GB 6, GB 7A, GB 7B, GB 16, GB 19 and GB 23 meet the requirements for approved classification using the Systematic Random Sampling Program (i.e. Geometric mean < 14 FC/100 ml and the 90th percentile < 43 FC/100ml). Sites GB 50 and GB 80 satisfy the criteria for restricted waters while GB 15 is prohibited.

VI. Interpretation of Data in Determining Area Classification

A. Meteorological and hydrographic effects on bacterial loading

The classification of the growing waters depends on the 90th percentile value calculated for water quality data. This value assumes that intermittent pollution events are unknown and random. One potentially identifiable and definable condition that may be a consistent cause of pollution is rainfall-associated runoff. Table 8 shows the number of DPHS or JEL samples associated with either rainfall events of >0.5 of rainfall during a 48 hour time period, or samples where <0.5 inches fell. In addition, the number of samples that had fecal coliform concentrations >43/100 ml are also noted for each rainfall condition. Overall, there were 54 DPHS and 68 JEL sample events (122 total) for which data was collected for one or more sites within the classified area. Of these samples, 19 occurred at times where >0.5" rain fell in 48 h, 6 of which had FC >43/100 ml and 13 had FC <43/100 ml. In addition, the 43 FC/100 ml value was violated 7 times following periods where <0.5' rain fell in 48 h, suggesting that pollution events are not consistently associated with rainfall. Referring to Table 3, there were 17 samples that had FC >43/100 ml. Four of these values were recorded on March 30, 1993, when 1.47" of rain had fallen in 48 h on top of deep snow, causing runoff associated with massive snow melt to occur. This phenomenon requires a specific set of conditions and has not occurred every year, or even frequently, in southeastern NH in the past ten years. Thus, rainfall and other meteorological events do not produce significant unfavorable effects on water quality that are consistent and definable in the classified area.

B. Variability in the data and causes

Nine of the 13 concentrations >43 FC/100 ml not associated with snowmelt occurred in December 1993 or 1994, when migratory birds are often present, especially at the northern and southern ends of the classified area. Feces from migratory birds can obviously cause elevated levels of FC in surrounding waters. However, many samples collected during times when birds are present were <14 FC/100 ml, suggesting that the effect of birds is localized to their immediate surroundings and have no consistent impact on the water quality of the growing area (Rivilla and Gonzalez, 1989). Overall, the frequency of samples >43 FC/100 ml is low, and the 90th percentile values calculated for 9 stations are <43 FC/100 ml. The critical public health concern about intermittent pollution events is that these events may represent periods when "...the shellfish may be exposed to enormous quantities of pollution" (NSSP, 1993). The magnitude of pollution recorded for the growing area from 1992-95 was never very high. For DPHS samples, the highest FC value was 170 at two sites on March 30, 1993, while 12/17 of the samples that were >43 FC/100 ml were <80 FC/100 ml. For JEL samples, the highest FC value was 270/100 ml at GB1 LT in May, 1994, while the other 7 samples that were >43 FC/100 ml were all <75 FC/100 ml. Thus, even with occasional undefined pollution events causing FC values to exceed 43/100 ml, the resulting contamination was still relatively mild and never constituted 'enormous quantities of pollution'. It should be noted that FC values in the classified area have been shown to be significantly higher following heavy rainfall events of >4" during 48 h periods. This has occurred twice during the last six years as recorded by JEL scientists: once during Hurricane Bob in 1991 when 6.06" fell in 2 days, and once in September, 1994 after 4.22" of rain fell in 48 h.

VII. Conclusions

A. Map showing classification

The proposed classification of the growing waters in the survey area are shown in Figure 10. Based on the results of this sanitary survey and analysis of the water quality database, it is recommended that the portion of Little Bay, beginning at a line drawn west-northwest from the tip of Fox Point in Newington (43°07'10" north latitude, 70°51'35" west longitude) to the southern shore of the mouth of the Oyster River at Durham Point (43°07'14" north latitude, 70°52'10" west longitude,) southward to the cable crossing be reclassified as approved. An analysis of the potential for impact from the Durham WWTP to the reclassified growing area in

Little Bay which was based on hydrographic data from a UNH Masters Thesis (Shanley, 1972) is reported in Appendix C. This analysis concludes that a plume of contaminated wastewater released from the Durham WWTP on the Oyster River could potentially reach the northern portion of the growing area under worst case conditions within 18-24 hours. This would allow the SSCA and the Patrol Agency sufficient time for area closure in the event of a release of untreated sewage from the Durham WWTP. Survey results and water quality database analysis also supports maintenance of an approved classification for the portion of Little Bay south of the cable crossing to Adams Point, in addition to the portion of Great Bay going south from Adams Point along the western shore of the Bay to Randall Point at the Durham-Newmarket line (43°04'50" north latitude, 70°53'27" west longitude), and all the growing waters east of a line drawn south-southeast from Randall Point to Sandy Point on the southern shore of Great Bay in Stratham (43°03'36" north latitude, 70°53'09" west longitude). The mouth of the Winnicut River, defined as the area southeast of a line running from Pierce Point (43°03'12" north latitude, 70*50'44" west longitude) in a west-southwest direction to the Greenland, NH shore (43°03'06" north latitude, 70°51'14" west longitude), should remain unclassified/prohibited. Water quality at the sample site nearest to this line (GB 16) meets the approved classification criteria (Table 3, Figure 5), however, there are no additional sample sites southeast of this line that could support another classification. Water quality studies support a restricted classification for a section of southwest Great Bay, while survey results support a prohibited classification for the far southwestern corner of Great Bay the includes the mouths of the Lamprey and Squamscott Rivers (Fig. 10)

B. Legal description

The approved classification area is defined as the growing waters bordered by the shoreline beginning at Durham Point on the western shore of Little Bay (43°07'14" north latitude, 70°52'10" west longitude) going southward along the western shore of Little Bay and Great Bay to Randall Point (43°04'50" north latitude, 70°53'27" west longitude), then defined by a line drawn south-southeast from Randall Point to Sandy Point on the southern shore of Great Bay in Stratham (43°03'36" north latitude, 70°53'09" west longitude), continuing along the southern shore of Great Bay to a line beginning at a point on the Greenland shore (43°03'06" north latitude, 70°51'14" west longitude) and ending at Pierce Point (43°03'12" north latitude, 70*50'44" west longitude), continuing east and north along the eastern shore of Great Bay and Little Bay, ending at Fox Point (43°07'10" north latitude, 70°51'35" west longitude). The restricted area is defined as the area bordered by the western shore of Great Bay beginning at Randalls Point (43°04'50" north latitude, 70°53'27"west longitude) going southward along this shoreline to the northern shore of Lubberland Creek (43°04'28" north latitude, 70°54'02" west longitude), then defined by a line from this point to Stratham Station on the southern shore of Great Bay (43°03'22" north latitude, 70°53'54" west longitude) following the shoreline eastward to Sandy Point (43°03'36" north latitude, 70°53'09" west longitude), then defined by a line going northwest from Sandy Point to Randall Point.

C. Management plan: Not Applicable

D. Recommendations for improvement of sanitary survey

In ensuing years, we recommend that sampling near the borders of the approved area be expanded to include more sites, especially at the northern boundary. The new sites should be established based on suspected sources of lingering contamination that appears intermittently between the mouths of the Oyster and Bellamy Rivers, and down to the General Sullivan Bridge. Another area of expansion could be up into the Oyster River, where it is wide with expansive mudflats near its mouth. Finally, a more detailed survey could be expanded out of Little Bay and into the Piscataqua River, to join up with other detailed survey areas.

It is important to maintain a schedule that allows for frequent sampling at all routine sites. The 90th percentile limit of 43 FC/100 ml can be violated if the database includes a significant proportion of high FC values. In other words, less frequent sampling may run greater risk of a small number of high values forcing classification of approved areas to be changed to a conditional classification. Conditional classifications require much more intensive management and a great deal of effort accurately define the exact condition under which areas need to be closed. Thus, frequent sampling in areas typically unaffected by pollution events will most likely support the more desired classification of approved.

VIII. References

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Table 1. Potential Pollution Sources Impacting the Growing Area with Relevant Sample Sites

	Potential Pollution Sources Within Growing Area			
Site	**Source**	**Water body**	**Impact**	**Relevant Sample Site**
PS1	Durham WWTP	Oyster River	Indirect	GB50
PS2	Newmarket WWTP	Lamprey River	Indirect	GB15
PS3	Newfields WWTP	Squamscott River	Indirect	GB80,JEL GB7
PS4	Little Bay Buffalo Farm	Little Bay	Indirect	GB23,GB6
PS5	Bittersweet Dairy Farm	Squamscott River	Indirect	JEL GB7
PS6	Stuart Farm	Squamscott River	Indirect	JEL GB7
PS7	Great Bay Farm	Great Bay	Indirect	GB16, 10S
PS8	Beck Horse Farm	Great Bay	Indirect	G/N4, 8S
PS9	Suspected malfunctioning septic	Great Bay	Direct	GB7B
PS10	McNeil Horses	Little Bay	Indirect	GB23
PS11	Drainage stream	Great Bay	Direct	G/N2
PS12	Foss Brook	Great Bay	Direct	G/N4
PS13	Malfunctioning septic/gray water pipe	Little Bay	Direct	GB 6, GB 7A

Table 2. Fecal coliform (#/100ml) counts at low and high tide for stations GB1 GB2, correlated with rainfall up to twenty four hours prior to sampling

					Rainfall (inches)	
					Day of	24 hr
DATE	GB1 LT	GB1 HT	GB2 LT	GB2 HT	cumulative	previous
1/11/93	18.0				0.02	0.00
2/9/93	2.5				0.00	0.00
3/4/93	15.0				0.00	0.00
3/23/93	15.0				0.00	0.00
3/29/93	2.0				0.46	0.00
4/22/93	8.0				0.06	0.00
5/6/93	8.5		7.5		0.05	0.00
5/11/93	16.0		17.0		0.07	0.00
5/20/93	18.0				0.39	0.39
6/2/93	4.5		2.0		0.83	0.83
6/3/93	5.0		16.0		0.00	0.00
6/7/93	6.0		9.5		0.47	0.47
6/24/93	6.0		15.0		0.00	0.00
6/28/93	0.8				0.00	0.00
7/5/93					0.00	0.00
7/12/93	4.3		13.8		Trace	0.00
7/19/93	0.3		0.3		0.00	0.00
7/26/93	0.8	0.3	2.0	2.3	0.00	0.00
7/27/93	0.3		0.3		0.61	0.00
8/3/93	1.0	2.0			0.54	0.11
8/9/93	3.5				0.28	0.00
8/18/93	1.0		2.5		1.06	0.00
8/25/93	2.8		11.3		0.02	0.00
9/7/93	2.0	5.5	21.5	2.3	0.00	0.00
9/22/93	2.8		4.8		0.02	0.00
10/5/93	1.8	14.8	5.3	4.8	0.05	0.00
10/12/93	5.3		12.0		0.09	0.00
10/18/93	2.0		2.5		Trace	Trace
10/25/93	4.0		12.8		0.00	0.00
11/9/93	1.5		2.3		0.00	0.00
12/15/93	8.8		38.3		0.13	0.08
1/13/94	63.0	73.0			0.90	0.00
2/21/94	25.5	47.5			0.00	0.00
3/29/94	1.5	51.0			0.28	0.13
4/27/94	18.8	32.0			0.60	0.60
5/11/94	5.5	8.0	14.5	6.0	0.00	0.00
5/18/94	9.5		10.5		Trace	0.25
5/25/94	25.0	24.0	43.5	13.0	0.52	0.10
5/31/94	270.0		32.0		0.00	0.00
6/8/94	0.8		8.0		Trace	Trace
6/23/94	5.5	0.8	8.8	0.5	0.00	0.00
6/28/94	4.8				0.28	0.00
7/6/94	1.0		2.0		0.00	0.00
7/11/94	0.8		7.5		Trace	Trace
7/18/94	0.5		3.5		0.00	0.00
7/21/94	1.3	2.0	2.5	1.8	Trace	0.00
7/25/94					0.21	0.21
8/1/94	1.8		20.0		0.00	0.00
8/8/94	1.0		4.0		0.00	0.00
8/15/94	1.8		6.0		0.08	0.08
8/23/94	2.5	2.0	7.3	0.8	0.35	0.33
9/6/94	8.3		38.5		1.08	0.62
9/7/94	4.5		6.0		0.62	0.62
9/8/94	4.5		10.5		Trace	Trace
9/19/94	3.0		7.5		0.77	0.77
10/4/94	3.5	3.0	5.8	4.0	0.00	0.00
10/11/94	6.0	4.3	7.8	3.5	0.00	0.00
10/18/94					0.00	0.00
10/25/94	7.8		8.6		0.00	0.00
11/21/94	8.5		6.3		0.00	0.00
12/19/94	5.8	2.0	10.8	8.3	0.41	0.41
1/26/95	61.5	36.0			0.00	0.00
2/20/95	13.0	7.5			0.00	0.00
3/20/95	8.3	10.3	11.0	7.0	0.00	0.00
4/11/95	0.5	29.3	0.5	6.0	0.24	0.24
5/23/95	1.3		3.5		0.16	0.16
5/30/95	3.5	6.0	10.0	5.3	0.50	0.19
6/5/95	2.0		12.5		0.00	0.00
6/13/95	5.8	2.8	16.8		0.18	0.02
# Samples(n)	67	22	49	14		
Geom mean	3.9	7.0	6.8	3.4		
Std. dev.	3.7	4.5	3.0	2.5		

Table 3. NH DPHS database for sampling sites relevant to the survey area from April 1992 to June 1995. Geometric means, 90th percentile score and and classifications of sites are also included. All scores in FC/100ml.

													Rainfall (inches)	
													Day of	24 hr prior
Date	GB 4A	GB 4B	GB5	GB6	GB 7A	GB 7B	GB 15	GB 16	GB 19	GB 23	GB 50	GB 80	cumulative	to sampling
4/6/92		4.5	1.8										0.00	0.00
4/13/92	4				2								0.18	0.18
4/14/92	1.8	2	2										0.00	0.00
4/20/92	4	1.8	4.5										Trace	Trace
5/25/92	4.5	4.5	4.5	4.5			790				13	4.5	Trace	Trace
6/22/92	7.8	2	2	1.8			1300				23	23	0.22	0.15
7/13/92	1.8	1.8	1.8	2			49				2	7.8	Trace	0.00
9/21/92	1.8	1.8	1.8	1.8			490				1.8	4.5	0.00	0.00
9/28/92	4	7.8	4.5	2			79				6.8	140	0.48	0.48
10/13/92	4.5	7.8	6.8	13	6.8	7.8	330				6.8	46	0.52	0.52
10/19/92	13	2	1.8	2			22				2	14	0.11	0.00
11/9/92	4.5	1.8	7.8	9.3	4	49	17				14	4.5	0.00	0.00
11/16/92				13							9.3		0.00	0.00
3/30/93	170	140	170	130							1100		1.47	0.46
4/27/93	79	13	4	1.8							1300		0.89	0.27
5/25/93	11	7.8	4.5	1.8			280				13	49	0.07	0.00
6/1/93	2	4.5	2	13			70				2	4	0.83	0.00
6/22/93	7.8	23	11	4.5			230				120	280	0.47	0.08
7/28/93	1.8	1.8	1.8	1.8			170				1.8	17	0.61	0.61
8/24/93	2	1.8	1.8	2			230				7.8	13	0.00	0.00
9/7/93	7.8	2	1.8	1.8			14				6.8	2	0.00	0.00
10/5/93	11	2	1.8	4			110				2	17	0.05	0.00
10/8/93			1.8			6.8	6.8						0.00	0.00
10/11/93			1.8			2	49						Trace	Trace
11/2/93	7.8	11	23	2			49				12	170	0.60	0.60
12/20/93	49	34	46	49			23				22	110	0.05	0.05
3/31/94				4.5	1.8								0.02	0.02
4/19/94	11	1.8	2	2			17				1.8		0.05	0.00
5/17/94	49	70	4.5	2			110				130		0.85	0.60

Table 3. NH DPHS database for sampling sites relevant to the survey area from April 1992 to June 1995. Geometric means, 90th percentile score and and classifications of sites are also included. All scores in FC/100ml.

													Rainfall (inches)	
													Day of	24 hr prior
Date	GB 4A	GB 4B	GB5	GB6	GB 7A	GB 7B	GB 15	GB 16	GB 19	GB 23	GB 50	GB 80	cumulative	to sampling
6/14/94	2	2	1.8	1.8			230				17	23	0.48	0.45
7/26/94	7.8	1.8	2	4.5			230				11	49	Trace	Trace
8/30/94	2	2	1.8	1.8	1.8	4.5	79		1.8	2	2	11	0.03	0.03
8/30/94	2	2	1.8	1.8		4.5	79	1.8	1.8		2	11	0.03	0.03
8/30/94				2									0.03	0.03
10/24/94	13	2	1.8	2	1.8	1.8	79	1.8	2	1.8	4.5	33	0.00	0.00
10/24/94				6.8				17					0.00	0.00
11/8/94	6.8	4.5	4.5	6.8	4	4.5	49	7.8	13	7.8	6.8	21	0.00	0.00
11/8/94										13			0.00	0.00
12/12/94				33	13	70		49	79	49			0.72	0.72
12/19/94				33	27	33		11	79	130			0.41	0.41
1/10/95				11	14	6.8		2	13	23			0.00	0.00
1/31/95				4.5	2	4.5		4	6.8	23			0.00	0.00
3/21/95		1.8		2	7.8	11		14	11	13	1.8		0.12	0.00
3/21/95				4.5									0.12	0.00
3/27/95				4.5	2	2		4.5	4.5	7.8			0.00	0.00
4/18/95		1.8		7.8	4.5	7.8		4.5	1.8	1.8	6.8		0.00	0.00
4/18/95				1.8						1.8			0.00	0.00
4/26/95					1.8	1.8		2	1.8	1.8			0.00	0.00
5/2/95				4.5		1.8		6.8	1.8	1.8	2		Trace	Trace
5/2/95				1.8		1.8							Trace	Trace
5/9/95					1.8	1.8		2	1.8	1.8			0.00	0.00
5/22/95					2	1.8		33	1.8	4.5			0.16	0.00
6/6/95	7.8	2	1.8	4.5	2	1.8		1.8	1.8	1.8			NA	NA
6/6/95					1.8	2		2	1.8	2	1.8	17	NA	NA
Geo Mean	**6.57**	**4.01**	**3.48**	**4.26**	**3.49**	**4.73**	**90.02**	**5.24**	**4.53**	**5.68**	**8.56**	**20.07**		
# samples	31.00	33.00	33.00	43.00	19.00	22.00	27.00	17.00	17.00	18.00	32.00	24.00		
90th %ile	29.7	17.8	13.6	16.2	10.4	20.1	465.6	21.0	24.5	32.4	79.5	102.6		
Classification	**A**	**A**	**A**	**A**	**A**	**A**	**P**	**A**	**A**	**A**	**R**	**R**		

Table 4. Fecal coliform concentrations (per 100 mL) at DPHS- established shoreline/surface water sites. Analyses by JEL.

DATE	CC	1S	1A	2S	3S	3A	4S	5S	5A	5B	6S	6A	7S	7A	8S	8A	9S	10S	11S	11A	12S	13S	13A	14S	15S
7/12/94	66	3	6	7	18		16	5	5	14											0	0	2	75	78
7/13/94												3		20	0	27	0	1	0	5					
7/14/94										5											2				
7/21/94										2	2		3												
8/9/94						14			75			19													
9/6/94	15																								
n=	2	1	1	1	1	1	1	1	2	3	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1
Geo. Mean	32	3	6	7	18	14	16	5	19	5	2	8	3	20	0	27	0	1	0	5	1	0	2	75	78

Table 5. Fecal coliform concentrations (per 100 mL) at sites in small tributaries surrounding Great Bay.

DATE	GN1	GN2	GN3	GN4	GN5	GN6	GN7	GN9	GN10	GN11
	Brackett Bk		Foss Brook		Shaw Bk	Packer Bk	Pickering Bk		McIntyre Bk	Winnicut R
7/21/94	10	298		2500	50	345	138	1	853	
7/27/94	2	360	233	700	23	180	18	10	545	113
9/6/94	18	4600		4700	160	355	64	172	165	250
n=	3	3	1	2	3	3	3	3	3	2
Geo. Mean	7	790	233	2019	56	280	54	12	425	168

Table 6. Effect of a storm event (1.08" on 9/5-9/6) in September, 1994, on fecal coliform concentrations (per 100 mL) at sites throughout the classified area.

Station	9/6/94	9/7/94	9/8/94	Geo. Mean (site)
GB6	10	4.0	3.0	4.9
GB50	40	16	7.0	16.5
GB7B (GB1)	8.3	4.5	3.0	4.8
GB5	6.0	2.8	0.5	2.0
(GB2)	39	11	7.5	14
GB4B (GB3)	101	23	23	38
GB4	57	38	40	44
GB15	765	150	60	190
GB80 (GB6)	75	69	65	69
(GB7)	110	260	157	165
Geo. Mean (date)	44	21	13	

Table 7. Comparison of paired monthly fecal coliform (#/100ml) concentrations (per 100 ml) at low (LT) and high (HT) tide for JEL stations GB1, GB2, GB4, and GB7: 7/93-6/95.

DATE	GB1 LT	GB1 HT	GB2 LT	GB2 HT	GB4 LT	GB4 HT	GB7 LT	GB7 HT
7/26/93	0.8	0.3	2.0	2.3	40	1.5	135	2.0
8/3/93	1.0	2.0						
9/7/93	2.0	5.5	22	2.3	135	2.0	56	15
10/5/93	1.8	15	5.3	4.8	26	2.3	13	2.3
1/13/94	63	73					109	44
2/21/94	26	48					38	9.0
3/29/94	1.5	51					285	24
4/27/94	19	32					33	42
5/11/94	5.5	8.0	15	6.0	29	3.0	51	3.5
5/25/94	25	24	44	13	104	53	350	140
6/23/94	5.5	0.8	8.8	0.5	38	0.3	18	8.3
7/21/94	1.3	2.0	2.5	1.8	19	0.3	15	7.5
8/23/94	2.5	2.0	7.3	0.8	29	2.0	71	5.5
10/4/94	3.5	3.0	5.8	4.0	25	0.8	62	1.0
10/11/94	6.0	4.3	7.8	3.5	32	3.3	126	8.5
12/19/94	5.8	2.0	11	8.3	16	5.5	48	3.5
1/26/95	62	36					93	83
2/20/95	13	7.5					37	38
3/20/95	8.3	10	11	7.0	11	38	5.5	18
4/11/95	0.5	29	0.5	6.0	16	1.5	36	4.5
5/30/95	3.5	6.0	10	5.3	112	4.5	2.0	44
6/13/95	5.8	2.8	17		50		129	8.0
Geom mean	**5.0**	**7.0**	**7.4**	**3.4**	**34.2**	**2.5**	**45.9**	**11.3**
Std. dev.	3.9	4.4	2.9	2.5	2.1	4.6	3.4	3.7
Paired t test results	HT > LT n. s.		LT > HT P < 0.05		LT > HT P < 0.05		LT > HT P < 0.05	

Table 8. Effect of significant rainfall events on fecal coliform concentrations at sites in the classified area.

#Samples with:	Source of data		
	DPHS	JEL	Total
Rainfall > 0.5"/48 h	8	11	19
FC > 43/100 ml	4	2	6
FC < 43/100 ml	4	9	13
Rainfall 0-0.5"/48 h	46	57	103
FC > 43/100 ml	3	4	7
FC < 43/100 ml	43	53	96

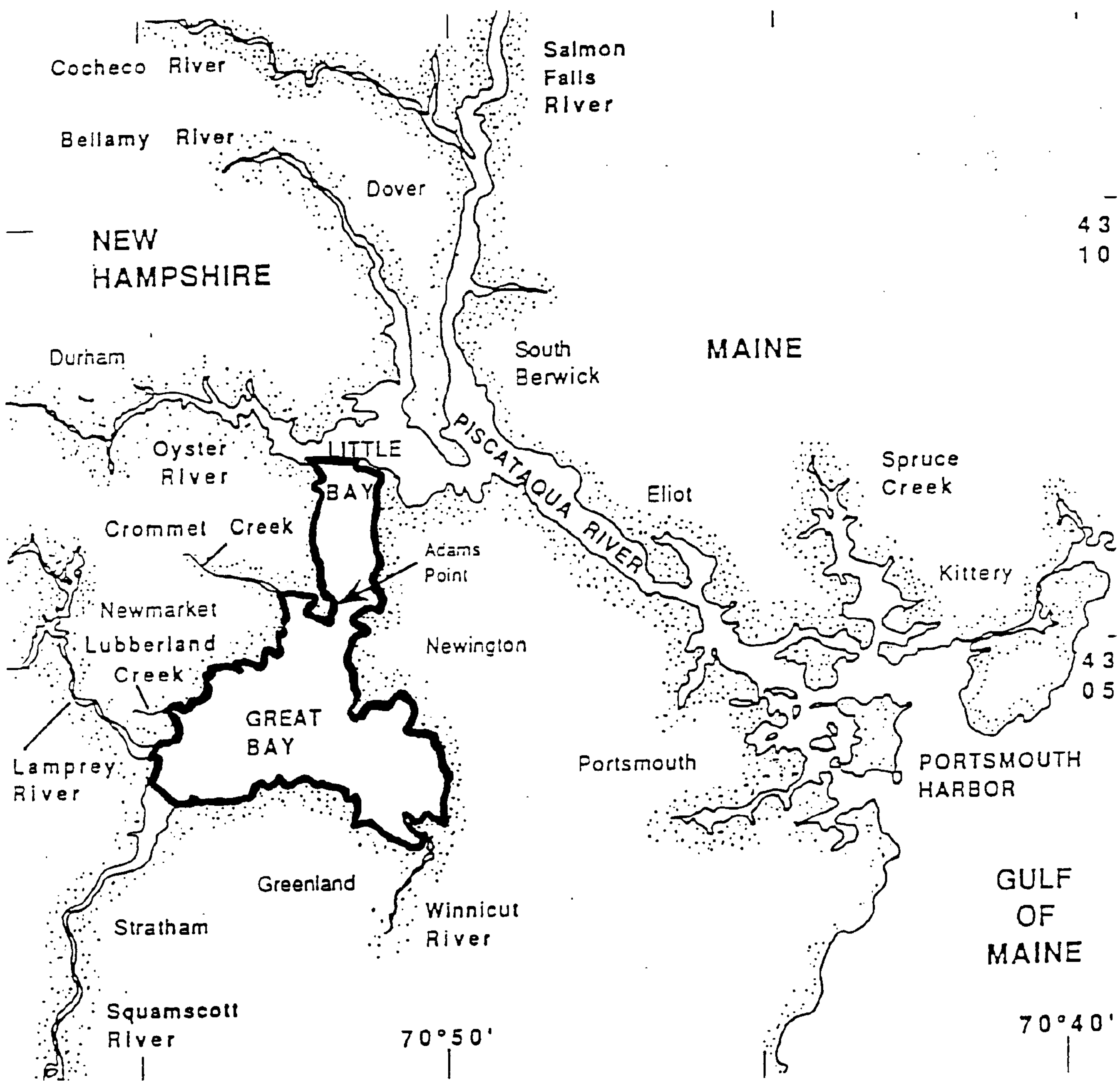


Figure 1. Map of the Great Bay Estuary with the survey area outlined in bold

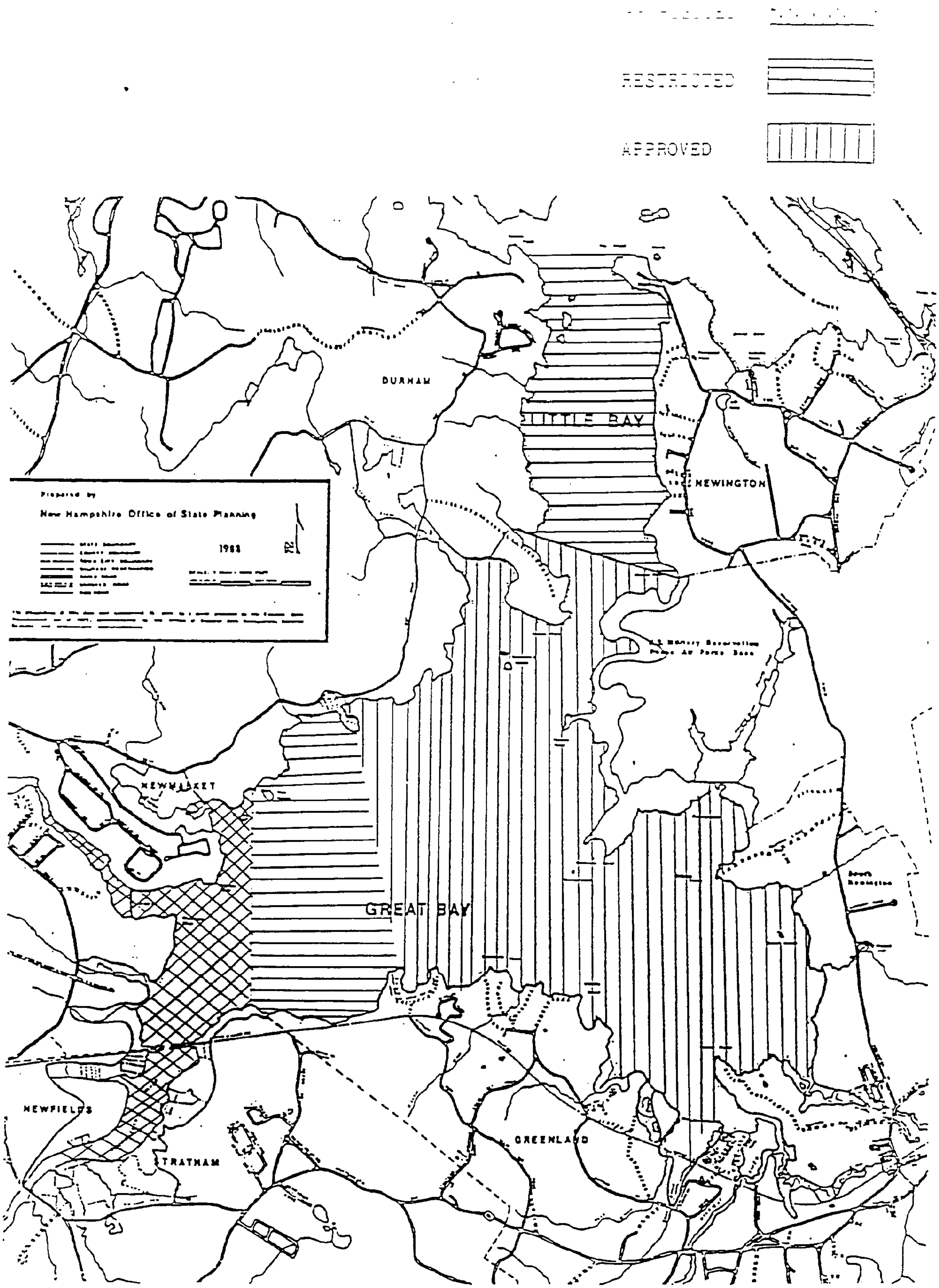


Figure 2. Classification of Growing Area Based on the 1991 Sanitary Survey

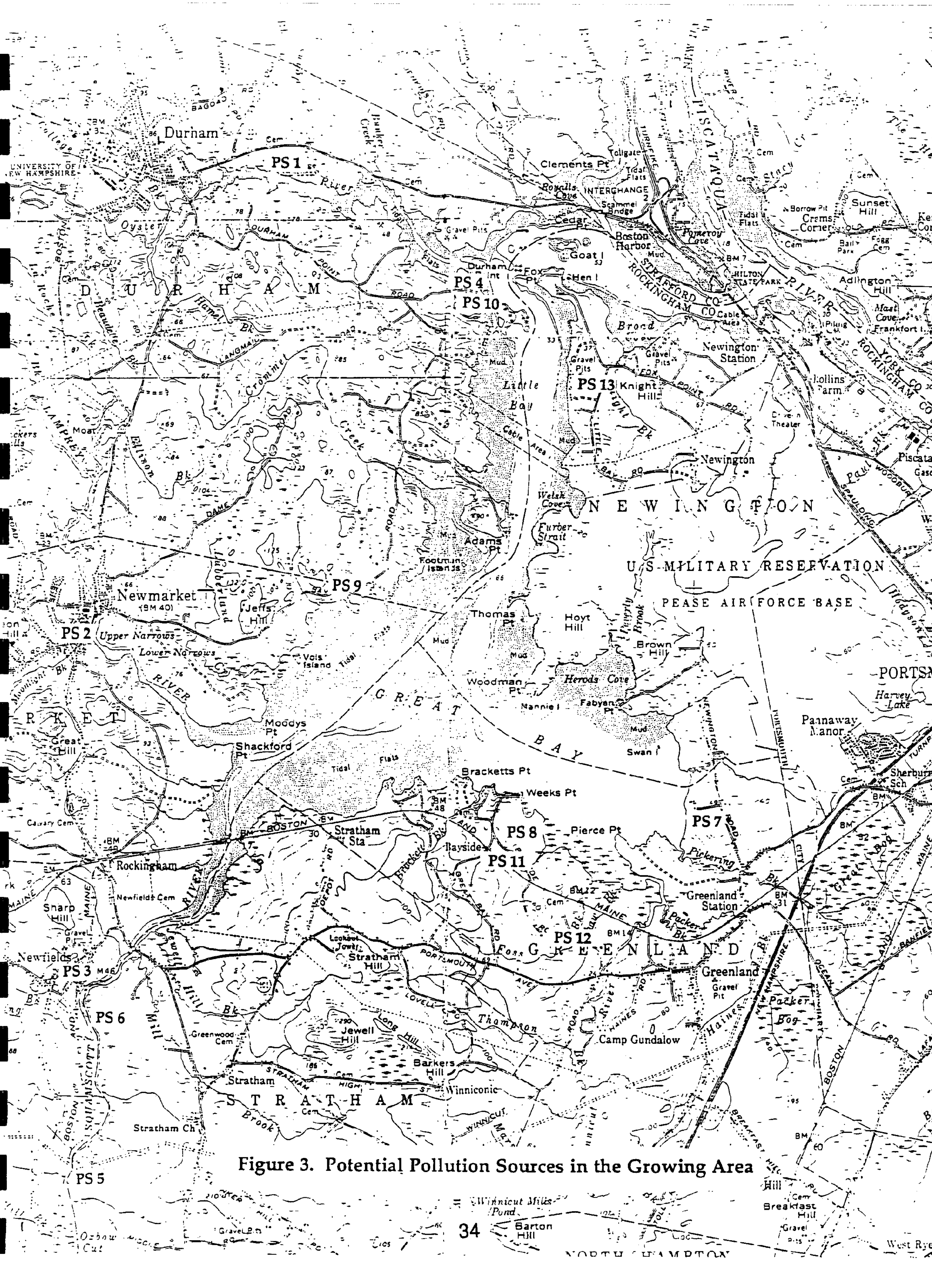


Figure 3. Potential Pollution Sources in the Growing Area

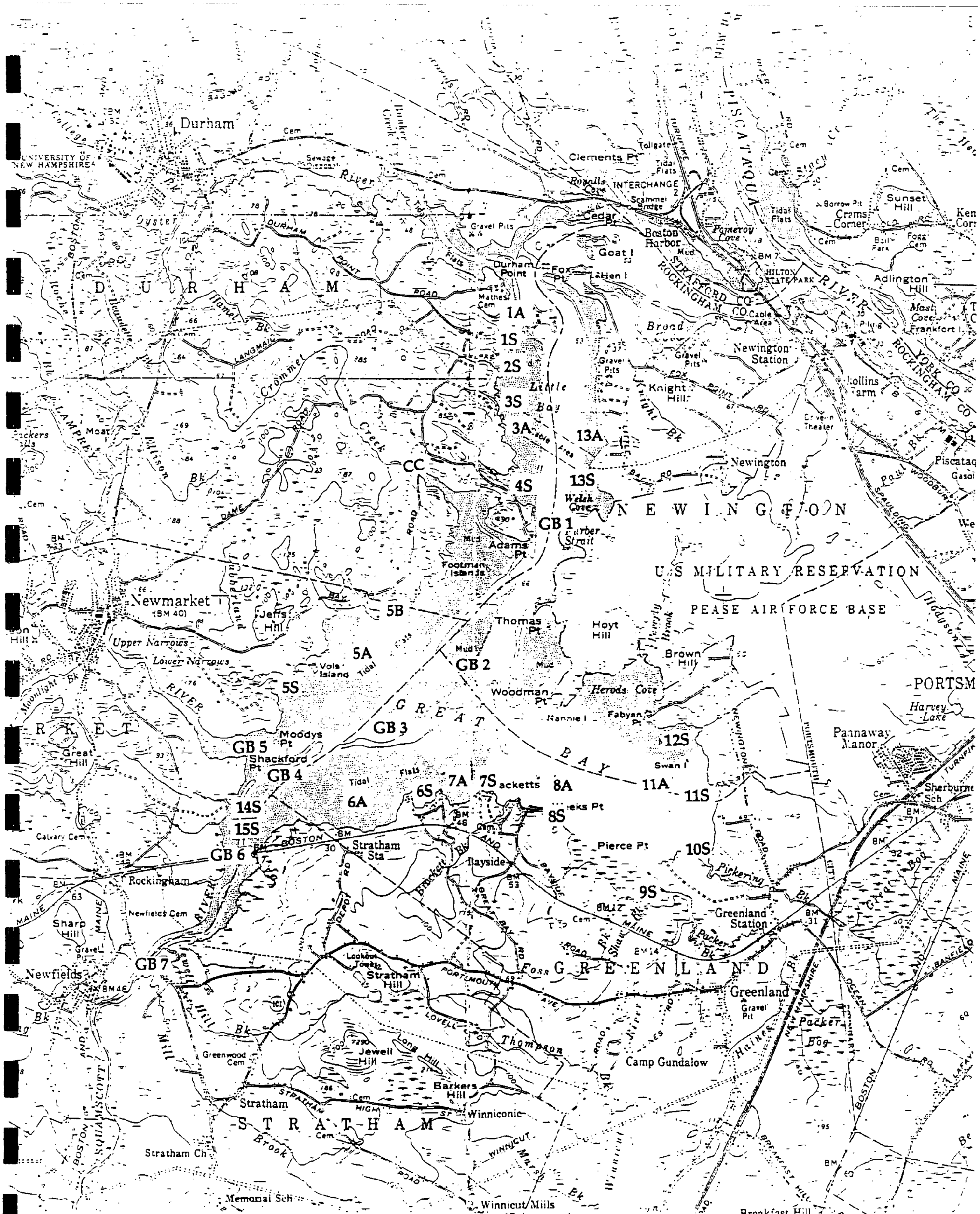


Figure 4. DPHS Shoreline Survey Sites (1990) and Jackson Lab GB sites

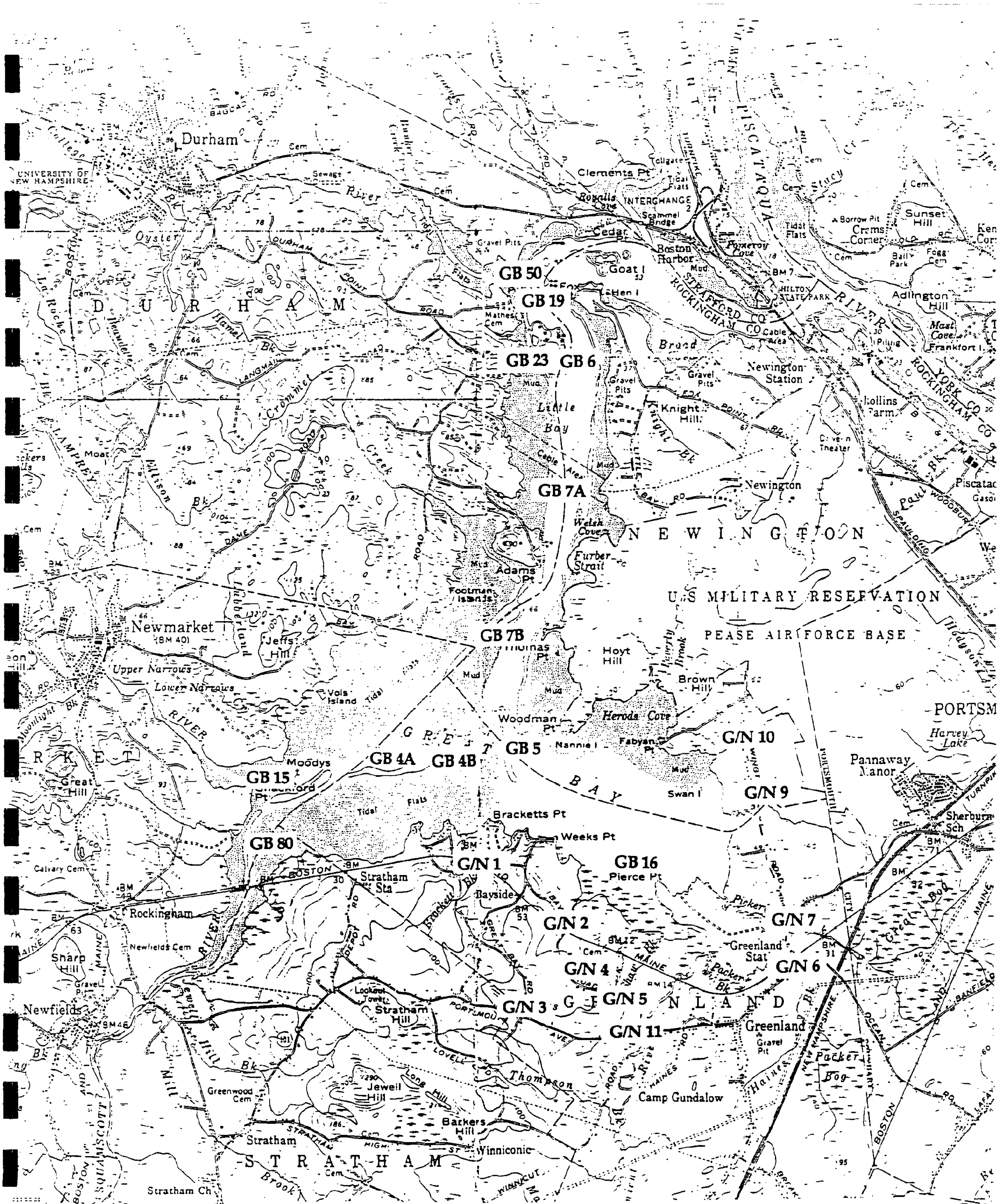


Figure 5. Routine Sampling Sites Within the Growing Area and Jackson Lab Tributary Sites

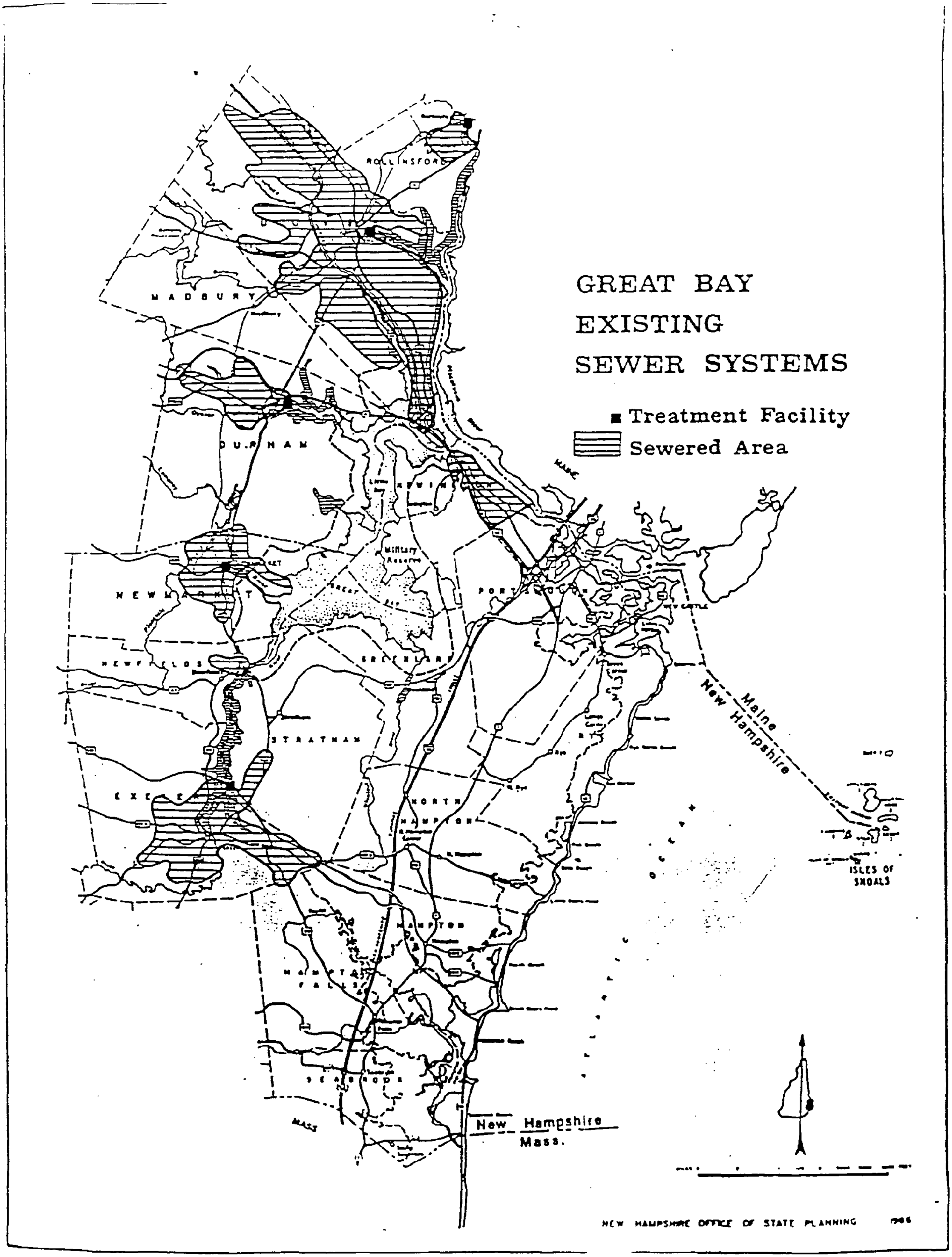


Figure 6. Sewered Areas Within the Growing Area

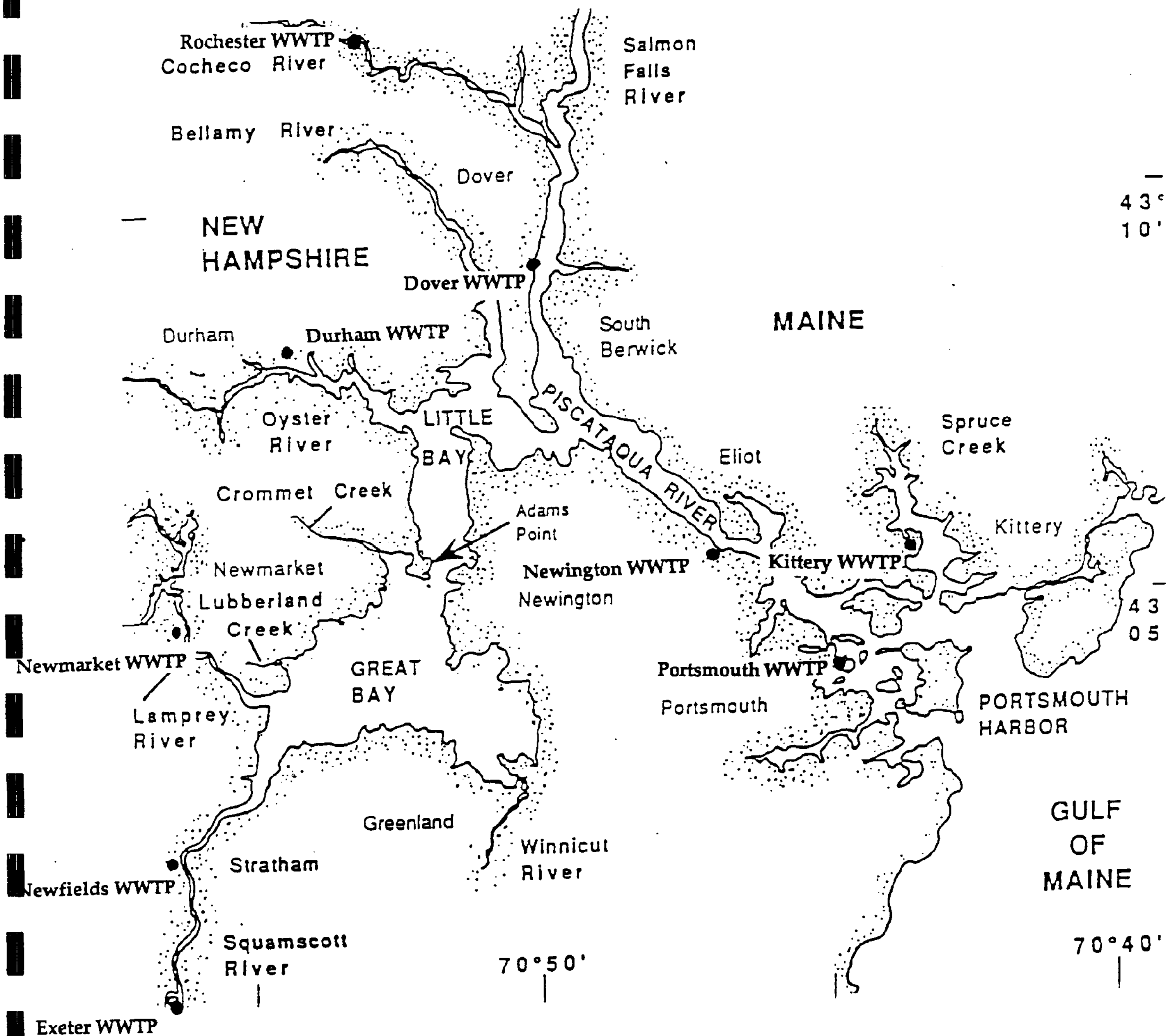


Figure 7. Wastewater Treatment Plants Within the Great Bay Estuary

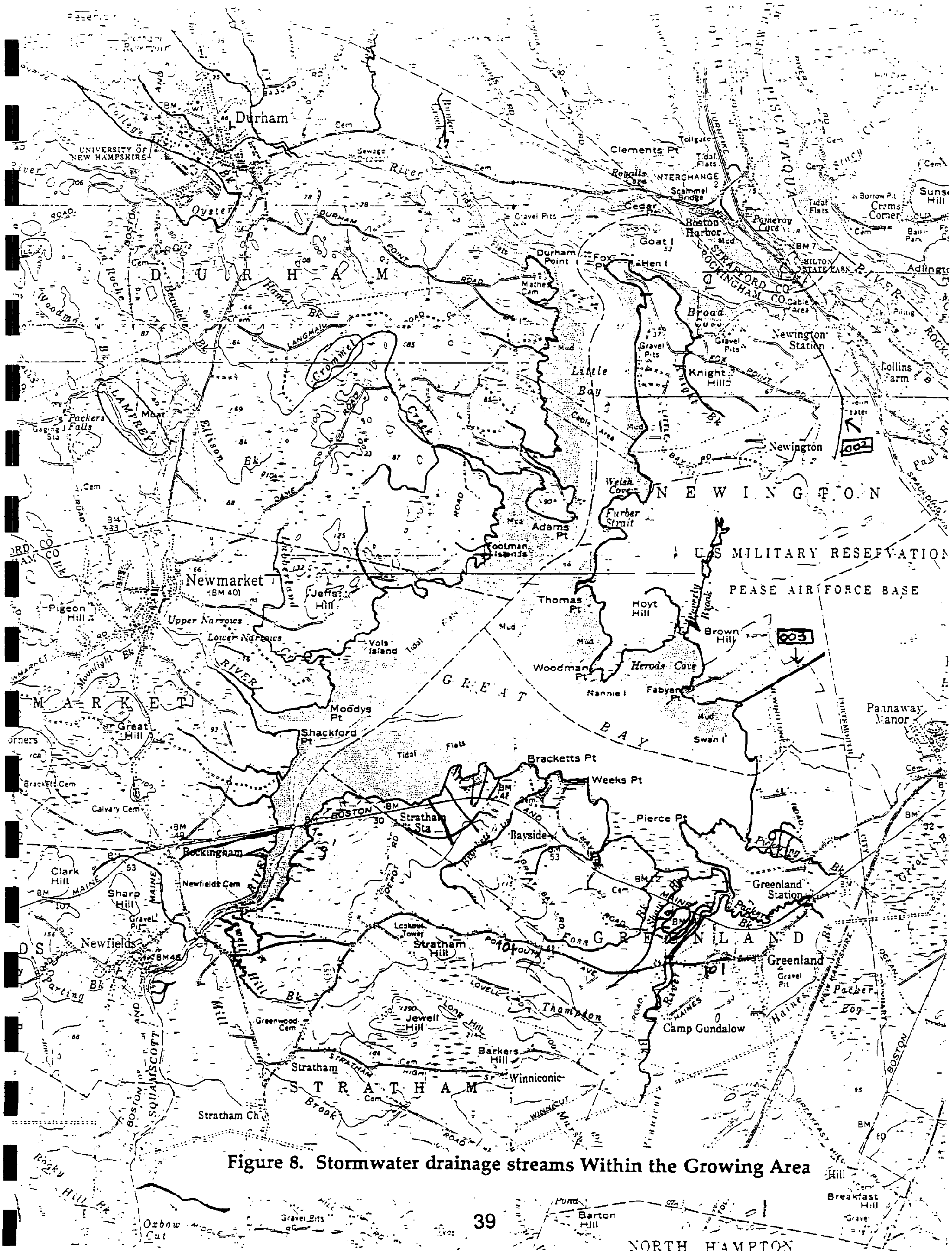


Figure 8. Stormwater drainage streams Within the Growing Area

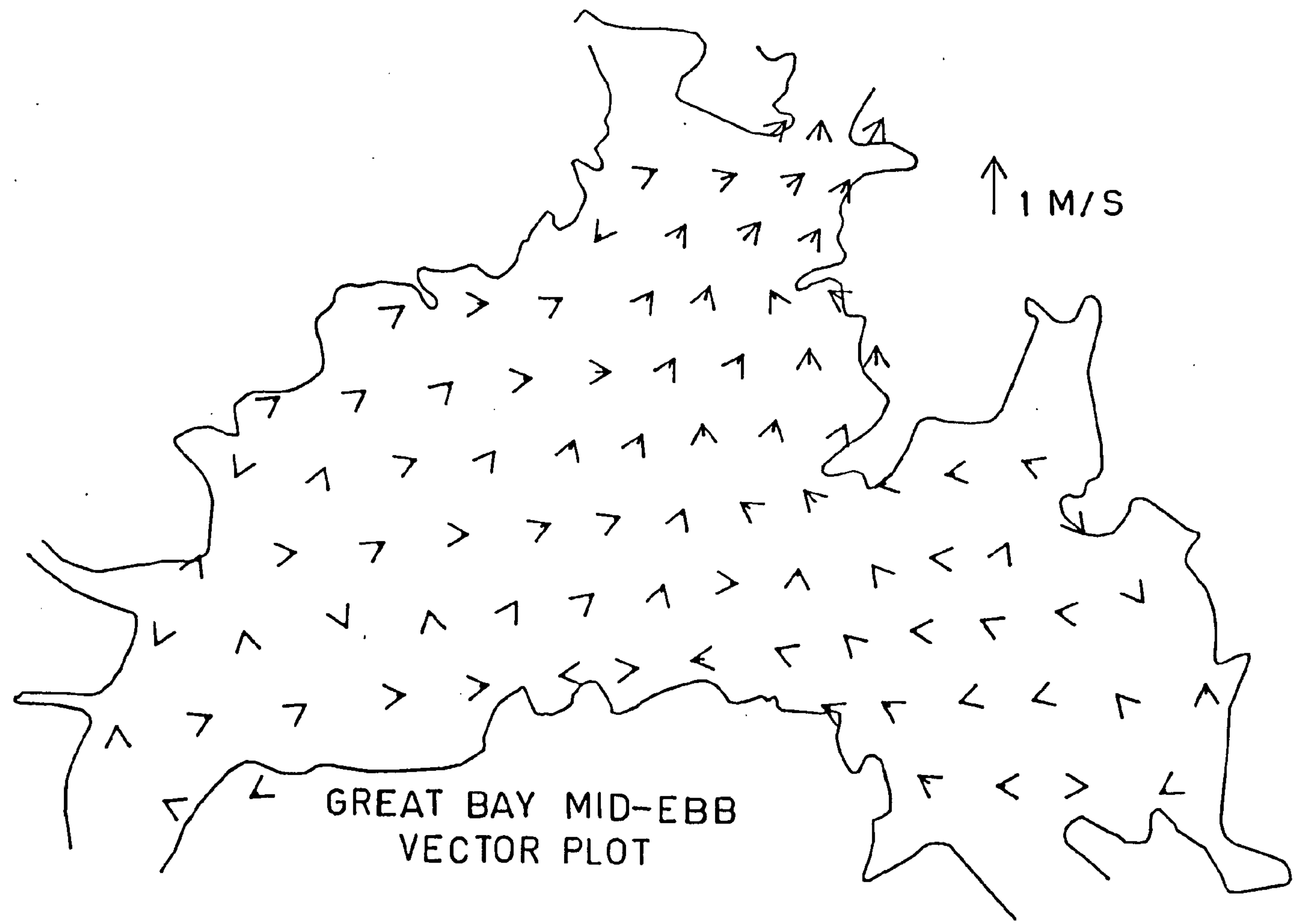


Figure 9A. Ebb current directional flow in Great Bay

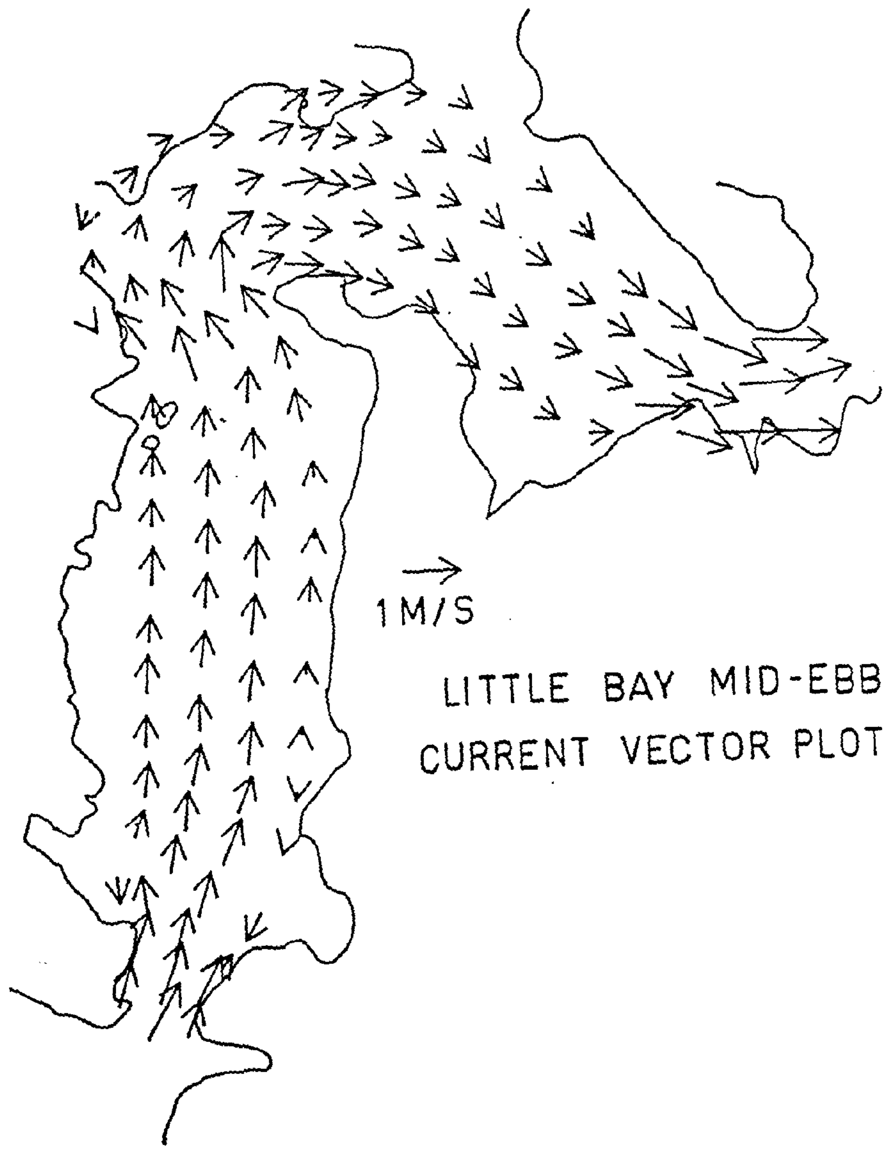
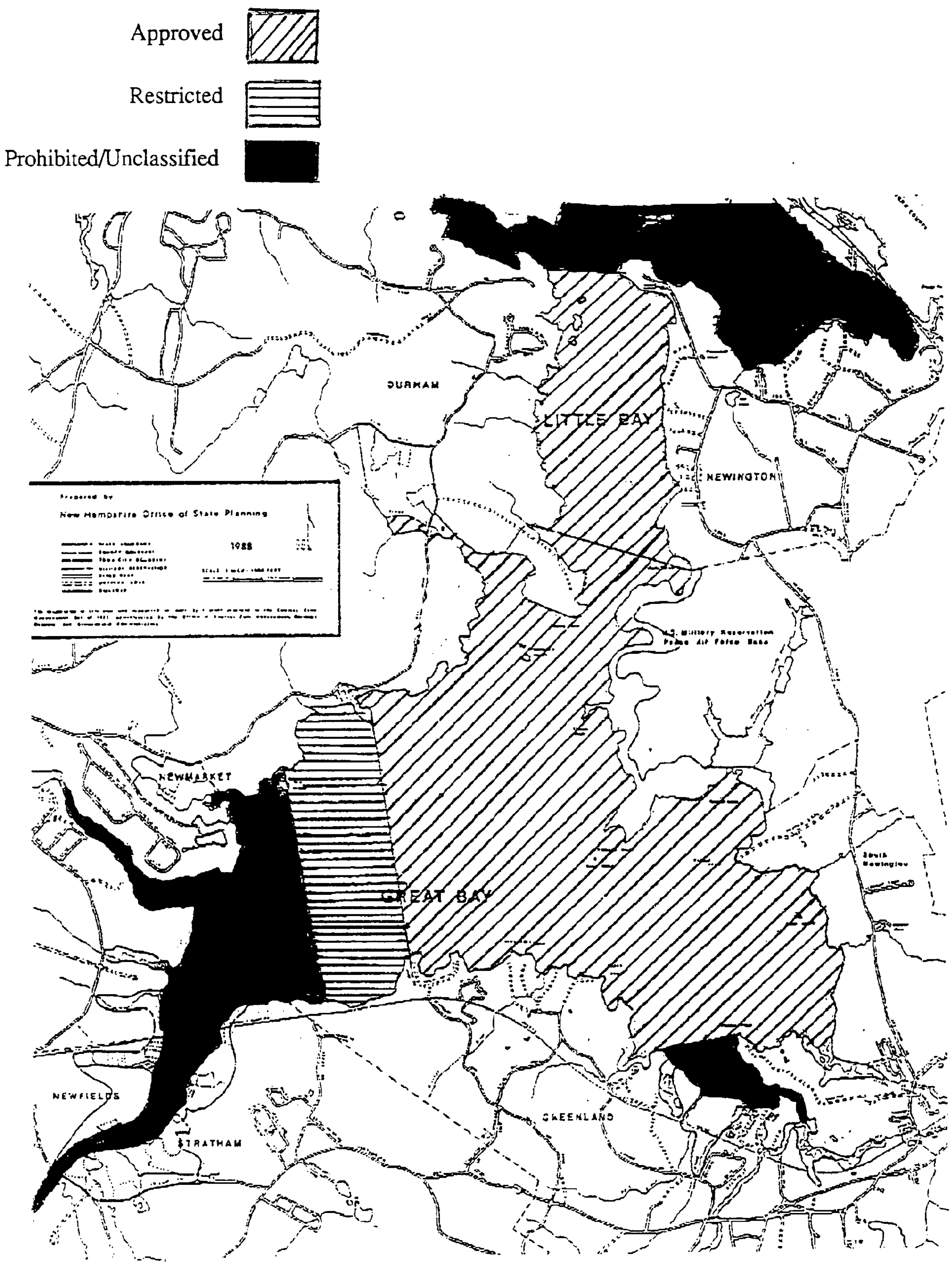


Figure 9B. Ebb current directional flow in Little Bay

Figure 10. A map of the survey area showing classification resulting from the 1995 Sanitary Survey.



PROPERTIES ON THE GREAT BAY

MAP/LOT	NAME	ADDRESS	FACILITIES/COMMENTS	INFO AVAILABLE
DURHAM				
12/5/02	MacLean	180 Piscataqua Road	Septic	House built 1969
12/8/02	Town of Durham	156 Piscataqua Road	Septic	House built 1780
12/9/08	Smith	30 Mathes Cove Road	Septic	See Septic sheet
12/9/09	Durnall	26 Mathes Cove Road	Septic	House built 1967
12/11/02	Poynter	2 Langley Road	Vacant lot	
12/12	Langley	off Langley Road	Vacant lot	
12/13/01	Langley	247 Durham Pt. Road	Septic	House built 1860, Buffalo farm
12/16/10	Casey	12 Willey Creek Road	Septic	House built 1975
12/16/11	Shafmasser	10 Willey Creek Road	Vacant lot	
12/16/12	Shafmasser	8 Willey Creek Road	Septic	House built 1976
12/16/13	Andrews	50 Colony Cove Road	Septic	House built 1976
12/16/14	Penhale	48 Colony Cove Road	Septic	House built 1974
12/17	McNeill	44 Colony Cove Road	Septic	House built 1969
12/19	McNeill	off Colony Cove Road	Vacant lot	
12/20	Benning	36 Colony Cove Road	Septic	House built 1975
12/21	Beckwith	34 Colony Cove Road	Septic	House built 1950
12/22	Auty	32 Colony Cove Road	Septic	House built 1961
12/23/01	Thompson	30 Colony Cove Road	Septic	See Septic sheet
12/24/01	Elms/Carlson	26 Colony Cove Road	Septic	
12/24/02	Nelson	28 Colony Cove Road	Septic	See Septic sheet
12/24/03	Pierce	24 Colony Cove Road	Septic	House built 1970
12/25	Lohnes	22 Colony Cove Road	Septic	House built 1976
12/27	Cooley	20 Colony Cove Road	Septic	House built 1925
12/28	Langley	Langley Island	Vacant lot	
12/29	Barrett	Bickford Island	Vacant lot	
19/13/6	Beckwith	Durham Point Road	Vacant lot	
19/13/7	McPhee	off Dame Road	Vacant lot	
19/13/8	Beckwith	376 Bay Road	Vacant lot	
20/1	Hoginski	595 Bay Road	Septic	House built 1950

20/2	Hancock	591 Bay Road	Septic	House built 1960
20/3/1	Bramante	587 Bay Road	Septic, guitar shaped pool	See Septic sheet
20/3/2	Cheney-England Ltd.	569 Bay Road	Septic	See Septic sheet
20/3/3	Harriton	583 Bay Road	Septic	See Septic sheet
20/3/4	Perlman	579 Bay Road	Septic, Pool	See Septic sheet
20/3/5	Cheney-England Ltd.	575 Bay Road	Septic	See Septic sheet
20/7/2	Cheney-England Ltd.	off Bay Road	Vacant lot	See Septic sheet
20/7/3	Cheney-England Ltd.	off Bay Road	Vacant lot	
20/7/4	State of NH	off Bay Road	Vacant lot	
20/7/5	State of NH	off Bay Road	Vacant lot	
20/7/6	State of NH	off Bay Road	Vacant lot	
20/7/7	State of NH	off Bay Road	Vacant lot	
20/8/1	Cochrane	off Bay Road	Septic	House built 1964
20/8/2	Danahy	off Bay Road	Septic	House built 1968
20/8/3	Randall	off Durham Point Road	Vacant lot	
20/8/4	Ford	433 Bay Road	Septic	
20/8/7	Cochrane	Lot #3 Bay Road	Vacant lot	
20/9/1	Congdon	off Bay Road	Septic	See Septic sheet
20/9/2	Loomis	367 Bay Road	Septic	See Septic sheet
20/10/1	Rous	64 Adams Point Road	Vacant lot	
20/10/2	Rous	50 Adams Point Road	Septic	See Septic sheet
20/11/1	Von Briesen	off Bay Road	Septic	House built 1720
20/11/2	DeCampi	55 Adams Point Road	Septic	See Septic sheet
20/12/1	Getchell	off Durham Point Road	Septic	See Septic sheet
20/12/3	Mills	off Durham Point Road	Septic	House built 1955
20/12/5	Rollins	Stonehouse Farm	Septic	
20/14/2	Kingman	275 Durham Point Road	Septic	House built 1850
20/14/3	Valpey	277 Durham Point Road	Septic	See Septic sheet
20/14/4	Kingman/McDonough	281 Durham Point Road	Vacant lot	
20/15	Rosebud Real Estate Trust	283 Durham Point Road	Septic	See Septic sheet
20/16/1	Chase	273 Durham Point Road	Septic	See Septic sheet
20/16/2	Whitaker	271 Durham Point Road	Septic, camp	Camp built 1960
20/16/3	Chase	269 Durham Point Road	Septic, camp	Camp built 1952

PROPERTIES ON THE GREAT BAY

20/16/4	Webb	265 Durham Point Road	Septic, ,camp	Camp built 1958
20/16/5	Otis	263 Durham Point Road	Septic, camp	Camp built 1960
20/16/6	Chase	267 Durham Point Road	Septic	See Septic sheet
20/18	McIntosh	Footman's Island	Camp-no facilities	
NEWMARKET				
R1/12	Zuk	11 Bayview Drive	Vacant lot	
R1/13	Cohen	13 Bayview Drive	Vacant lot	
R1/14	Cohen	15 Bayview Drive	Septic	House built 1970
R1/15	Cohen	17 Bayview Drive	Vacant lot	
R1/16	Cohen	19 Bayview Drive	Vacant lot	
R1/17	Zuk	21 Bayview Drive	Vacant lot	
R1/18	Zuk	23 Bayview Drive	Vacant lot	
R1/19	Pardo	25 Bayview Drive	Vacant lot	
R1/20	Fotiades/Moskoff	28 Bayview Drive	Septic	House built 1910, Septic redone 1979
R1/21	Fotiades/Moskoff	26 Bayview Drive	Septic	Camp, built 1910, Septic redone 1979
R1/22	Zuk	20 Bayview Drive	Septic	House and septic put in 1970's
R1/23	Zuk	18 Bayview Drive	Vacant lot	
R1/24	Atherton	14 Bayview Drive	Septic	House built 1951
R1/28	Pitman	12 Bayview Drive	Vacant lot	
R1/29	Pitman	10 Bayview Drive	Vacant lot	
R1/30	Zuk	8 Bayview Drive	Vacant lot	
R1/34	Pitman	252 Bay Road	Septic	House built 1951
R1/35	Popov	246 Bay Road	Vacant lot	
R1/36	Popov	230 Bay Road	Septic	See Septic Sheet
R1/37	Hatch	210 Bay Road	Septic	House built 1960
R1/38	Cheney-Smith	200 Bay Road	Septic in process	See Septic Sheet
R1/38/4	Cheney-Smith	15 Barberry Coast	Vacant lot	
R1/38/5	Cheney-Smith	18 Barberry Coast	Septic	House built 1924
R1/38/6	Cheney-Smith	14 Barberry Coast	Septic	House built 1920
R1/38/7	Southeast Bank	10 Barberry Coast	Vacant lot	
R1/38/8	Southeast Bank	6 Barberry Coast	Vacant lot	
R1/39	Pearson	Little Bay Road	Vacant lot	

R1/40	Southeast Bank	Vols Island	Vacant lot	
R2/36/1	White	Lubberland Drive	Accessory buildings only	
R2/36/2	Moody Pt. Co.	2 Lubberland Drive	Vacant lot	
R2/36/3	Moody Pt. Co.	3 Cushing Road	Vacant lot	
R2/36/4	Moody Pt. Co.	511 Cushing Road	Town sewer	Condos
R2/36/5	Moody Pt. Co.	5 Cushing Road	Vacant lot	
R2/36/6	Jay Howland Enter.	Cushing Road	Vacant lot	
R2/38	Jaferian	5 Moody Pt. Drive	Vacant lot	See Septic Sheet
R2/40	Great Bay Trust	11 Moody Pt. Drive	Vacant lot	
R2/41	Germain	15 Moody Pt. Drive	Septic	House built 1979
R2/41A	Batt	13 Moody Pt. Drive	Septic	House built 1978
R2/42	Davidson	17 Moody Pt. Drive	Septic	House built 1952
R2/43/1	Weeks	19 Moody Pt. Drive	Septic	See Septic Sheet
R2/43/2	Chaves	21 Moody Pt. Drive	Septic	See Septic Sheet
R2/44A	Chaves	23 Moody Pt. Drive	Vacant lot	
R3/36	Watson Estate of Wm.	81 New Road	Septic	House built 1790
R3/41/2	Labonte	117 New Road	Vacant lot	
R3/42	Beaudet	131 New Road	Septic	See Septic sheet
R3/42A	Heald	3L New Road	Vacant lot	
R3/43	Champagne	off New Road	Septic	Camp built 1750
R3/44	Hanrahan/Hamel	161 New Road	Septic	House built 1960
NEWFIELDS				
201/4	Boston and Maine RR	Railroad trestle	No facilities	
201/5	Hauschel	on Squamscott River	Vacant lot	
201/6	Cheney-Smith	on Squamscott River	Vacant lot	
201/8	LeGault	on Squamscott River	Vacant lot	
201/9	Long	Route 108	Vacant lot	
201/10	Williams	Route 108	Vacant lot	
201/13	Laboute	on Squamscott River	Vacant lot	
201/14	Rogers	on Squamscott River	Seasonal camp, no facilities	
201/15	Edgerley	on Squamscott River	Septic	See Septic sheet
201/20	Great Bay Campground	Route 108	Septic	See Septic sheet

201/23	Hayden	Route 108	Tree/horticultural crops	House >800 ft
201/26	Chace	Route 108	Storage garage, no facilities	
STRATHAM				
3/37	NH Fish and Game	88 Rt 108	Chapman's Landing, Septic	House built 1940,50 ft
3/39	NH Fish and Game	Rt 108	Vacant lot	Saltmarsh, Chapman's Lnd.
3/40	Turnberry Condo., Inc.	142 Portsmouth Ave	Vacant lot	Saltmarsh, condo commonland
3/41	Turnberry Condo.,Inc.	off Squamscott Road	Vacant lot	Saltmarsh, condo commonland
3/42	Turnberry Condo.,Inc.	off Squamscott Road	Vacant lot	Saltmarsh, condo commonland
3/43	Turnberry Condo., Inc.	off Squamscott Road	Vacant lot	Saltmarsh, on Squam. House Cr.
5/1	Batcheider	off Squamscott Road	Vacant lot	
5/2	Wiggin	off Squamscott Road	Vacant lot	
5/23	Crow	off River Road	Vacant lot	
5/23/01	Harrington	off Jason Road	Camp, not used	Outhouse approx. 150 ft
5/24	MacDougall	1 Linda Lane	Septic	House >1000 ft
5/25	Town of Stratham	off Linda Lane	Vacant lot	
5/27/03	Brookside Condos	off Depot Road	Garage for storage only	
5/31	State of NH	off Depot Road	Vacant lot	Saltmarsh
5/32	Rue	37 Depot Road	Vacant lot	Saltmarsh
13/23/36	Atlantis Realty Trust	Morning Star Drive	Vacant lot	
13/23/53	Dumbarton Oaks	off Dumbarton Oaks	Vacant lot	Dumbarton Oaks commonland
GREENLAND				
R13/5	NH Fish and Game	89 Depot Road	Septic, NERR GB Center	See Septic sheet
R13/8	Tessier	90 Depot Road	Vacant lot	
R13/9	Scofield	off Depot Road	Vacant lot	
R13/12	Brackett	43 Great Bay Drive West	Vacant lot	
R13/13	Defillipo	66 Great Bay Drive West	Septic	
R13/14A	Strong	60 Great Bay Drive West	Septic	Septic about 15 years old
R13/17	Schneider	100 Great Bay Drive West	Septic, camp	
R13/18	Snyder	50 Great Bay Drive West	Septic, camp	
R13/19	Lee	3 Great Bay Drive East	Septic	House built 1992

PROPERTIES ON THE GREAT BAY

R13/20	Brackett	15 Great Bay Drive East	Septic	
R13/21	Hession	off Great Bay Drive East	Septic	
R13/22	Pinney	21 Great Bay Drive East	Septic	Septic redone about 1985
R13/23	Digiovanni	23 Great Bay Drive East	Accessory building only	
R13/24	Digiovanni	25 Great Bay Drive East	Septic	
R14/1	Brandes	29 Great Bay Drive East	Septic	
R14/2	Thomas	33 Great Bay Drive East	Septic	
R14/2A	Dixon	31 Great Bay Drive East	Septic	
R14/3	Johnson	37 Great Bay Drive East	Septic	
R14/3A	MacTaggart	35 Great Bay Drive East	Septic	House and septic about 1972
R14/4	Bliss	41 Great Bay Drive East	Septic	
R14/5	MacTaggart/Johnson	35 Great Bay Drive East	Vacant lot	
R14/6	Portsmouth Savings Bk.	43 Great Bay Drive East	Septic	
R14/7	Myers	45 Great Bay Drive East	Septic	See Septic sheet
R14/8	Carter	51 Great Bay Drive East	Septic, camp	
R14/10	Moreau	30 Bayridge Road	Septic, camp	
R14/11	Vickery	24 Bayridge Road	Septic, camp	
R14/12	Middleton	28 Bayridge Road	Septic	
R14/13	Weeks	off Brackett's Pt. Road	Farm	
R14/14	Brackett	22 Brackett's Pt. Road	Septic	Main house, camp septics 1930-1970's
R14/18	Weeks	667 Bayside Road	Septic	Main house, camp septics 1930-1960's
R14/30	King	32 Bayridge Road	Septic	See Septic sheet
R14/32	Wohlgethan	22 Bayridge Road		
R15/2	Beck	632 Bayside Road	Septic, pool	Horse farm
R15/5	Town of Greenland	off Bayside Road	Vacant lot	
R15/10	McCarthy	7 Meloon Road	Septic	
R15/19	Underwood	off Meloon Road	Septic	
R15/20	Town of Greenland	off Meloon Road	Vacant lot	Saltmarsh
R15/21	Town of Greenland	off Meloon Road	Vacant lot	Saltmarsh
R15/22	Town of Greenland	off Meloon Road	Vacant lot	Saltmarsh
R15/23	Town of Greenland	off Meloon Road	Vacant lot	Saltmarsh
R18/1	NH Waterfowl Assoc.	Backland	Vacant lot	
R18/3	Town of Greenland	Backland	Vacant lot	

PROPERTIES ON THE GREAT BAY

R18/9	Wick	4 Bayview Terrace	Septic	See Septic sheet
R18/10	Wentworth	2 Bayview Terrace	Septic	See Septic sheet
R18/11	Westley	18 Bayshore Drive	Septic	See Septic sheet
R18/12	Mayer	13 Fairview Terrace	Septic	
R18/13	Fay	5 Fairview Terrace	Septic	See Septic sheet
R18/14	Zwolinski	2 Fairview Terrace	Septic	See Septic sheet
R18/28	Sanderson	off Bayshore Drive	Vacant lot	Saltmarsh
R18/29	Sanderson	off Bayshore Drive	Vacant lot	Saltmarsh
R18/30	Sanderson	off Bayshore Drive	Vacant lot	Saltmarsh
R18/31	Sanderson	off Bayshore Drive	Vacant lot	Saltmarsh
R18/34	Hughes	110 Tide Mill Road	Vacant	Current use
R21/15	Ports. Country Club	80 Country Club Ln.	Septic	
R22/1	Smith, Rev.Trust	125 Newington Road	Dairy Farm	
R22/3	Emery	161 Newington Road	Septics, 2 homes	See Septic sheet
R22/4	White	201 Newington Road	Vacant	
U10/8	Pickerings Brook Ltd.	27 Pickering Brook Drive	Vacant lot	
U10/9	Pickerings Brook Ltd.	26 Pickering Brook Drive	Vacant lot	
NEWINGTON				
1/1	Town of Newington	Fox Point-all	Vacant lot	
1/2	Butler	Goat Island	Vacant lot	
4/1	Eames	371 Fox Point Road	Septic	See Septic sheet
4/2	Lembcke	385 Fox Point Road	Accessory buildings only	
4/3	Blevins	397 Fox Point Road	Septic	House built 1968
4/4	Vinciarelli	off Fox Point Road	Septic	See Septic sheet
9/2	Ackerley	325 Fox Point Road	Septics, 2 residences	See Septic sheet
9/3	Lamson	71 Little Bay Road	Vacant lot	
9/4	Lamson	42 Little Bay Road	Septic	House built 1949, 100ft
9/4A	Lamson	42 Little Bay Road	Vacant lot	
9/5	Lamson	50 Little Bay Road	Septic	House built 1963, 20 ft
9/6	Mahoney	off Little Bay Road	Septic	House built 1930, 100ft
9/7	Lamson	40 Little Bay Road	Septic	See Septic sheet

PROPERTIES ON THE GREAT BAY

9/8	Lamson	off Little Bay Road	Vacant lot	
9/9	Lamson	off Little Bay Road	Vacant lot	
15/1	Witham	80 Little Bay Road	Septic	See Septic sheet
15/2	Bowser	84 Little Bay Road	Septic	See Septic sheet
15/3	McGee	104 Little Bay Road	Septic, Pool	Seasonal, blt. 1966, 100 ft
15/4	Lane	108 Little Bay Road	Septic	See Septic sheet, Seasonal
15/5	Davis/Perkins	112 Little Bay Road	Septic	House built 1930
15/6	Trefethen	116 Little Bay Road	Septic	House built 1970, 100 ft
15/7	Russell	148 Little Bay Road	Septic	House built 1975, 100 ft
15/8	Hill	168 Little Bay Road	Septic	See Septic sheet
15/10	Cabrera	136 Little Bay Road	Vacant lot	
15/11	Cabrera	136 Little Bay Road	Septic	House built 1960
22/3	Smith	30 Gundalow Landing Circle	Septic	See Septic sheet
22/4	Ross	40 Gundalow Landing Circle	Septic	See Septic sheet
22/5	Beswick	44 Gundalow Landing Circle	Septic	See Septic sheet
22/6	Purohit	52 Gundalow Landing Circle	Septic	House built1985, 100 ft
22/7	Parkinson	4 Brickyard Way	Septic	See Septic sheet
22/8	Eichler	151 Little Bay Road	Vacant lot	
22/13	Myers	188 Little Bay Road	Septic	House > 700 ft
23/31	Wolf	34 Welsh Cove Drive	Vacant lot	
23/32	Hazelton	44 Welsh Vove Drive	Septic	See Septic sheet
23/33	Frink	251 Little Bay Road	Vacant lot	
29	Pease			
35	Pease			
40	Pease			
41	Pease			
45	Pease			
46	Pease			
47/1	Thomas	509 Newington Road	Septic	House built 1790
49	Pease			
50/1	Beals	162 Fabyan Point Road	Septic	See Septic sheet
50/2	Drinkwater	off Fabyan Point Road	Septic, cottage	House built 1930
51/1	Field	395 Newington Road	Vacant lot	

PROPERTIES ON THE GREAT BAY

51/2	Upson	425 Newington Road	Septic	See Septic sheet
51/2A	Smith	405 Newington Road	Septic	See Septic sheet
51/3	Hodgdon	off Newington Road	Septic	House built 1840
51/4	Bullock	73 Fabyan Point Road	Septic	House built 1970
53/5	Baird	316 Newington Road	Septic	House built 1945
53/6	Mazeau	315 Newington Road	Septic	House blt. 1670, ren. 1958
53/7	Mazeau	315 Newington Road	Vacant lot	
53/8	Thomas	349 Newington Road	Septic	House built 1900
53/9&9A	Berounsky	off Swan Island Lane	Vacant lot	
53/11	Connors	381 Newington Road	Septic	House built 1971
53/12	Welch	385 Newington Road	Septic, Pool	House built 1974
53/16	Berounsky	off Swan Island Lane	Septic	See Septic sheet
55/1	White	75 Newington Road	Vacant lot	

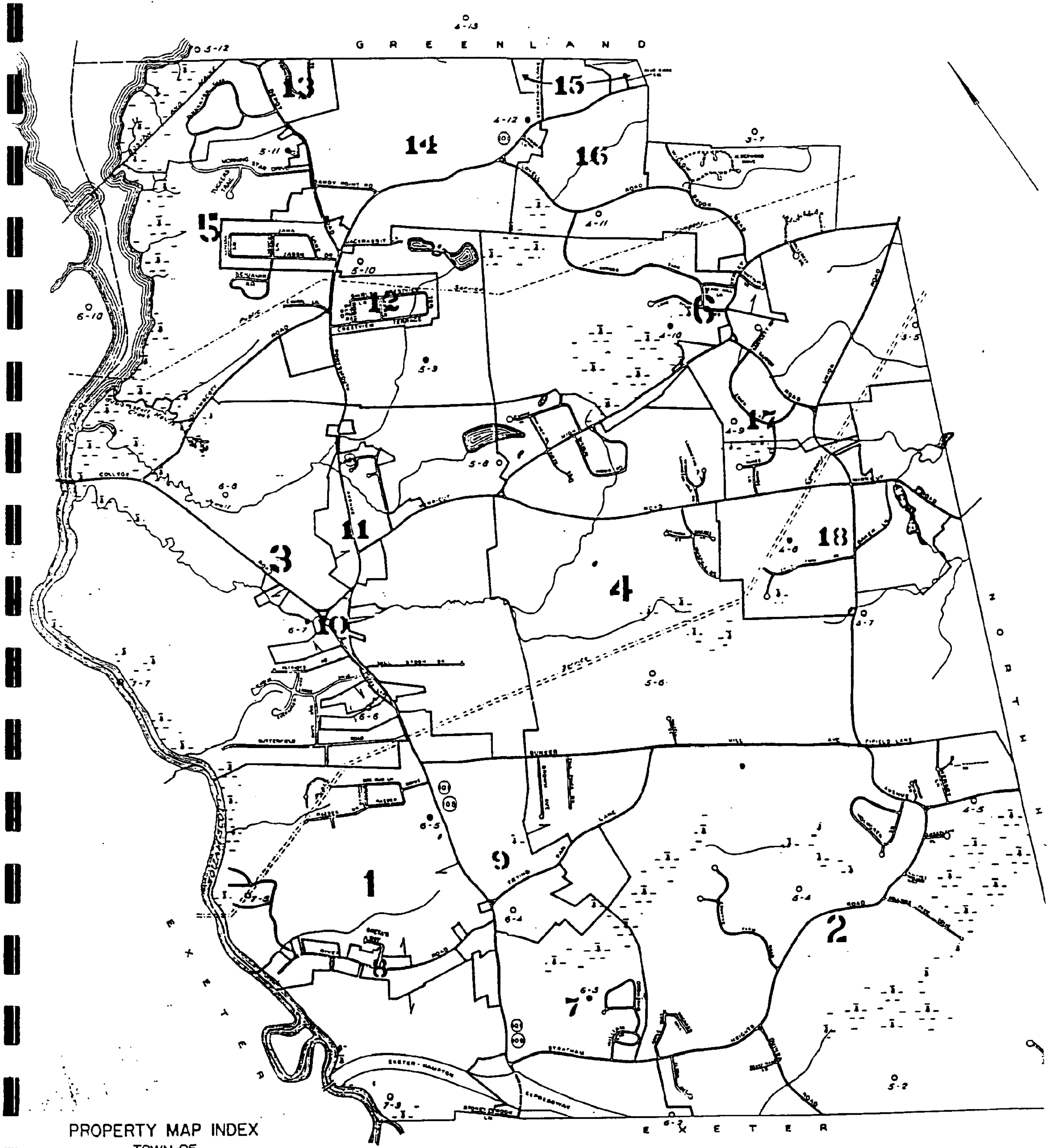
MAP/LOT NUMBER	APPROVAL DATE	TYPE BDRM	PERC M/IN	TANK GAL	FIELD SQ FT	SOIL TYPE	W.T. IN	ESHWT IN	LEDGE IN	DISTANCE TO SURFACE H20	COMMENTS
DURHAM											
12/9/08	3/80	4		1500	1520	BUXTON	120	24	120	100 FT	
12/13/01	4/91	1	9	1000	405	HOLLIS-CHARLTON	ND	24	ND	100 FT	1 BR APT OVER GARAGE
12/13/01	2/93	NA	24	1250	1350	HOLLIS-CHARLTON	NA	22	NA	> 75 FT	
12/16/10	2/74	4	18	1000	880	BZB	NA	NA	NA	NA	
12/16/12	11/72	4	55	1000	1600	BUXTON	30	NA	27	> 75 FT	
12/16/13	8/71	3	40	900	840	BUXTON	NA	NA	72	150 FT	
12/16/14	10/74	3	50	900	930	BUXTON	NA	NA	NA	> 75 FT	
12/17	6/71	3	45	1000	900	BUXTON	NA	NA	NA	NA	
12/23/01	6/70	2-2BR	5	2-1000	500	HOLLIS-CHARLTON	NA	NA	NA	135 FT	
12/24/02	11/87	3	8	1000	450	BUXTON SILT LOAM	NA	35	72	110 FT	
20/2	6/09	NA	NA	1000	600	NA	NA	NA	NA	130 FT	
20/3/1	11/82	4	5	1000	800	FINE SANDY LOAM	NA	20	61	> 100 FT	
20/3/2	9/91	6	2	**	NA	BUXTON-SCANTIC	23	NA	20	100 FT	**2 TANKS-1500,2500 GAL
20/3/3	6/80	4	9	1000	640	HOLLIS CHARLTON	NA	20	36	NA	
20/3/5	5/80	3	20	1000	1340	BUXTON	20	11	NA	> 75 FT	
20/7/2	5/92	4	20	1500	1170	HOLLIS CHARLTON	NA	23	30	100 FFT	
20/8/4	5/82	2	30	1000	875	BUXTON	36	36	63		
20/8/6	5/91	7	7	2000	1940	BUXTON	NA	18	74	> 125 FT	
20/9/1	10/79	4	20	1000	1790	BUXTON	NA	13	NA	140 FT	
20/9/2	12/93	4	8	1000	1000	HOLLIS-CHARLTON	NA	NA	NA	>75 FT	
20/10/1	4/83	3	20	1000	1125	HOLLIS-CHARLTON	NA	16	16	90 FT	
20/10/2	4/83	4	6	1000	901	HOLLIS-CHARLTON	NA	29	29	180 FT	
20/10/2	5/93	4	20	1500	900	HOLLIS-CHARLTON	NA	16	16	180 FT	
20/11/2	5/93	4	20	1500	900	HOLLIS-CHARLTON	NA	18	18	150 FT	
20/12/1	7/82	2	14	1000	650	HOLLIS-CHARLTON	NA	NA	48	>110 FT	
20/14/3	7/85	3	6	1000	480	HOLLIS-CHARLTON	NA	41	72	>350 FT	

SEPTIC SYSTEM INFORMATION

20/15	6/84	4	20	1000	760	HOLLIS-CHARLTON	NA	12	48	>75 FT	
20/16/1	2/90	3	14	1000	576	HOLLIS-CHARLTON	NA	20	40	100 FT	
NEWMARKET											
R1/36	12/92	2	8	1000	NA	CHATFIELD H&C	NO.	5	NO.		
R1/38	8/94	4	12	1500	756	40B SHAPLEIGH GL	24	36	72	100 FT	
R2/38	10/94	4	12	1600	720	460B PENNICHUCK	0	20	48	75 FT	
R2/40	2/92	3	32	1250	832	BUXTON	NO.	12	NO.	125 FT	
R2/43-1	6/90	3	8	1000	480	CHATFIELD HOLLIS	NO.	NO.	NO.	>75 FT	
R2/43-2	8/88	3	14	1000	576	Hh	NO.	NO.	NO.	100 FT	
R2/44A	6/87	3	14	1000	576	Hh	NO.	NO.	NO.	100 FT	
R3/42	8/88	3	20	1000	704	CHATFIELD H&C	NO.	84	NO.	128 FT	
NEWFIELDS											
201/15	12/84			NO SEPTIC INFO						75 FT	
201/20	3/86									300 FT	Septic for 95 Campsites
											Approval # 102934
GREENLAND											
R13/5	5/94	open	6	1050	1125	WINDSOR	NA	NA	NA	75 FT	Sandy Point Discovery Ctr.
R14/7	2/92	3	60	1500	800	BUXTON/SCANTIC	20	14	NO.	75 FT	
R14/30	10/78	3	NA	NA	975	NA	NA	NA	NA	150 FT	
R14/32	12/80	3	28	1000	1500	Gc	NO.	NA	NA	100 FT	
R18/9	7/88	4	6	1000	540	38B	60	28	NO.	75 FT	
R18/10	7/84	3	20	1000	373	Ta	60	72	NO.		
R18/11	8/84		12	1000	NA	Ea/Ta	NA	32	NA	75 FT	
R18/13	10/83	3	3	1000	NA	Ea/Ta	NA	24	NA	75 FT	
R22/3	11/93	5-2BR	8	2-1500	2800	460C PENNICHUCK	25	30	NA	100 FT	
R22/3	11/93	4	8	1500	1000	460C PENNICHUCK	24	31	NA	100 FT	
NEWINGTON											

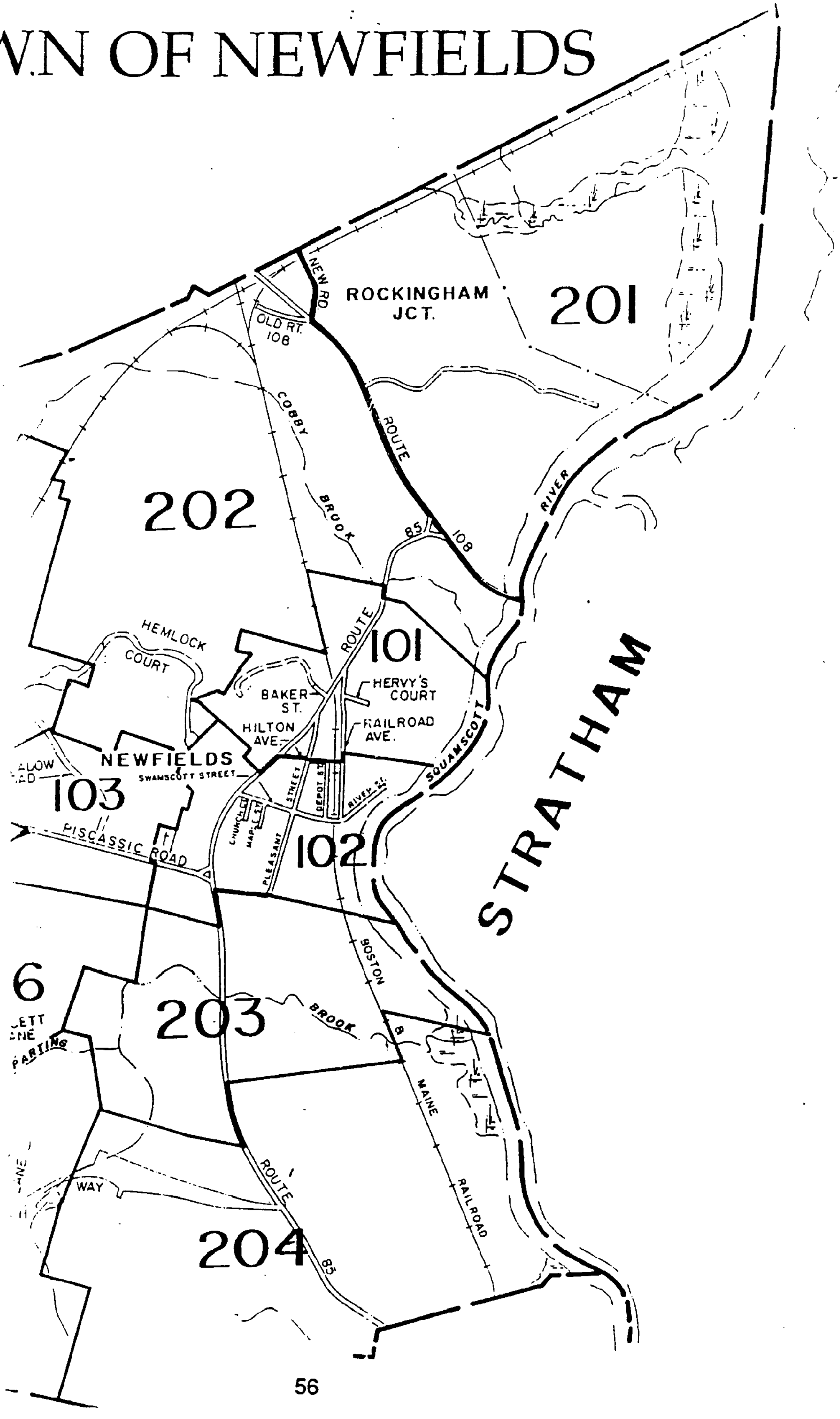
SEPTIC SYSTEM INFORMATION

4/1	10/78	2	2.5	1000	430	WF	NA	NA	NA	>100 FT	
4/4	12/77	3	2.5	1000	700	Mp	NA	60	NA	100 FT	
9/2	7/70	3	<3	1000	NA	Hc	120	NA	120	100 FT	
9/2	7/80	2	3	NA	500	Hc Hinkley	NA	NA	NA	150 FT	
9/7	11/91	3								>175 FT	App. # 189804
15/1		3									App. # 139885
15/2	3/91	4								100 FT	App.# 179328
15/4	3/84	4								100 FT	App. # 107746, Replaced
15/8	6/71	3	<1	1000	140	Sandy clay	NO.	NA	NO.	120 FT	
22/3	4/85	5									App. # 120352
22/4	8/85	4									App. # 124481
22/5	8/85	4									App. # 125221
22/7	8/87	4									App. # 138020
23/32	6/94	4	2	1600	750	26A Windsor	NO.	72	NO.	150 FT	
50/1	3/76	2									App. # 52678
51/2	10/93	3									
51/2A	7/92	3									App. # 191478
53/16	10/91	3									App. # 189535



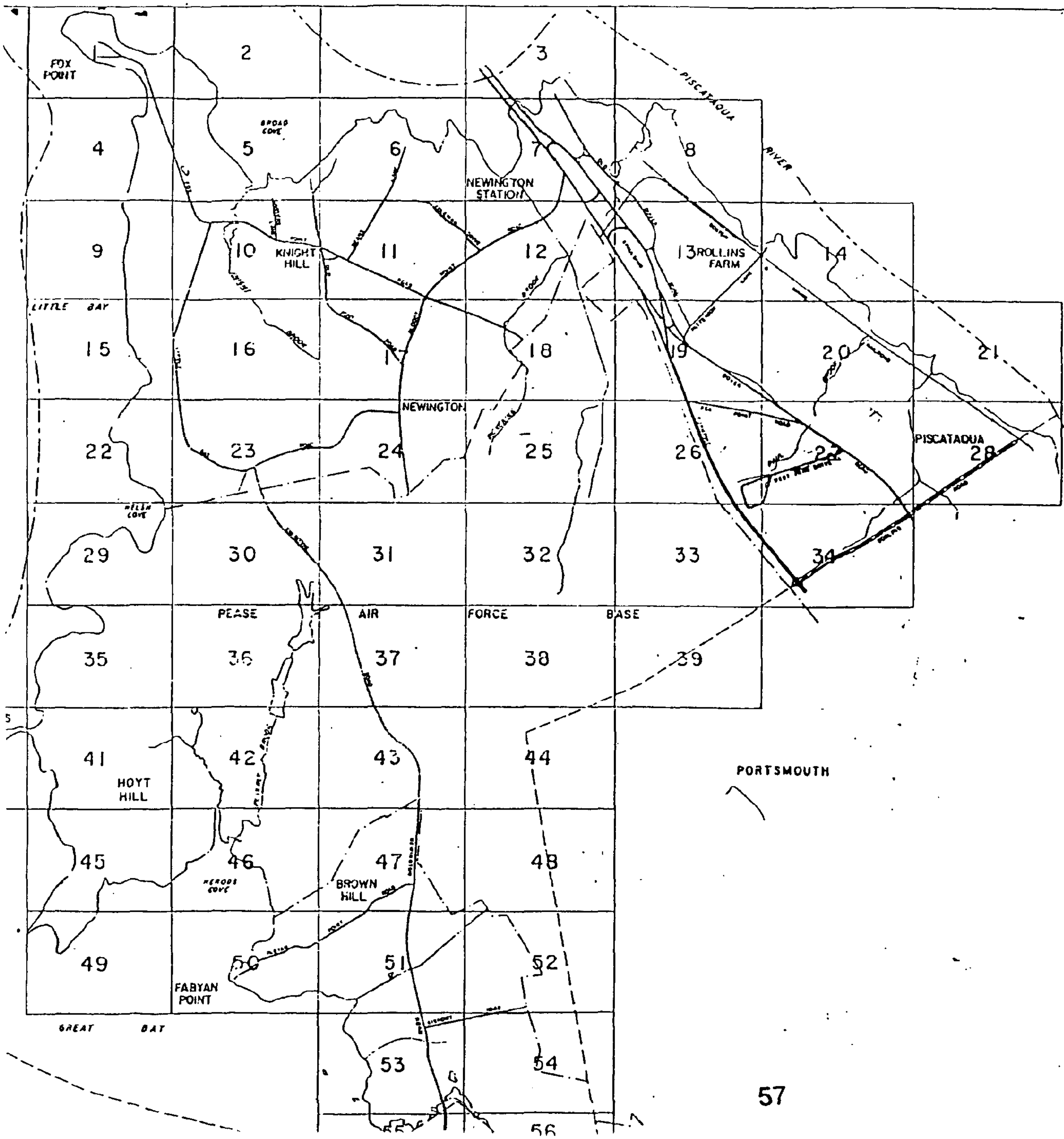
PROPERTY MAP INDEX
TOWN OF
STRATHAM
ROCKINGHAM COUNTY, N.H.
1974
JAMES W SEWALL COMPANY, OLD TOWN, MAINE
SCALE

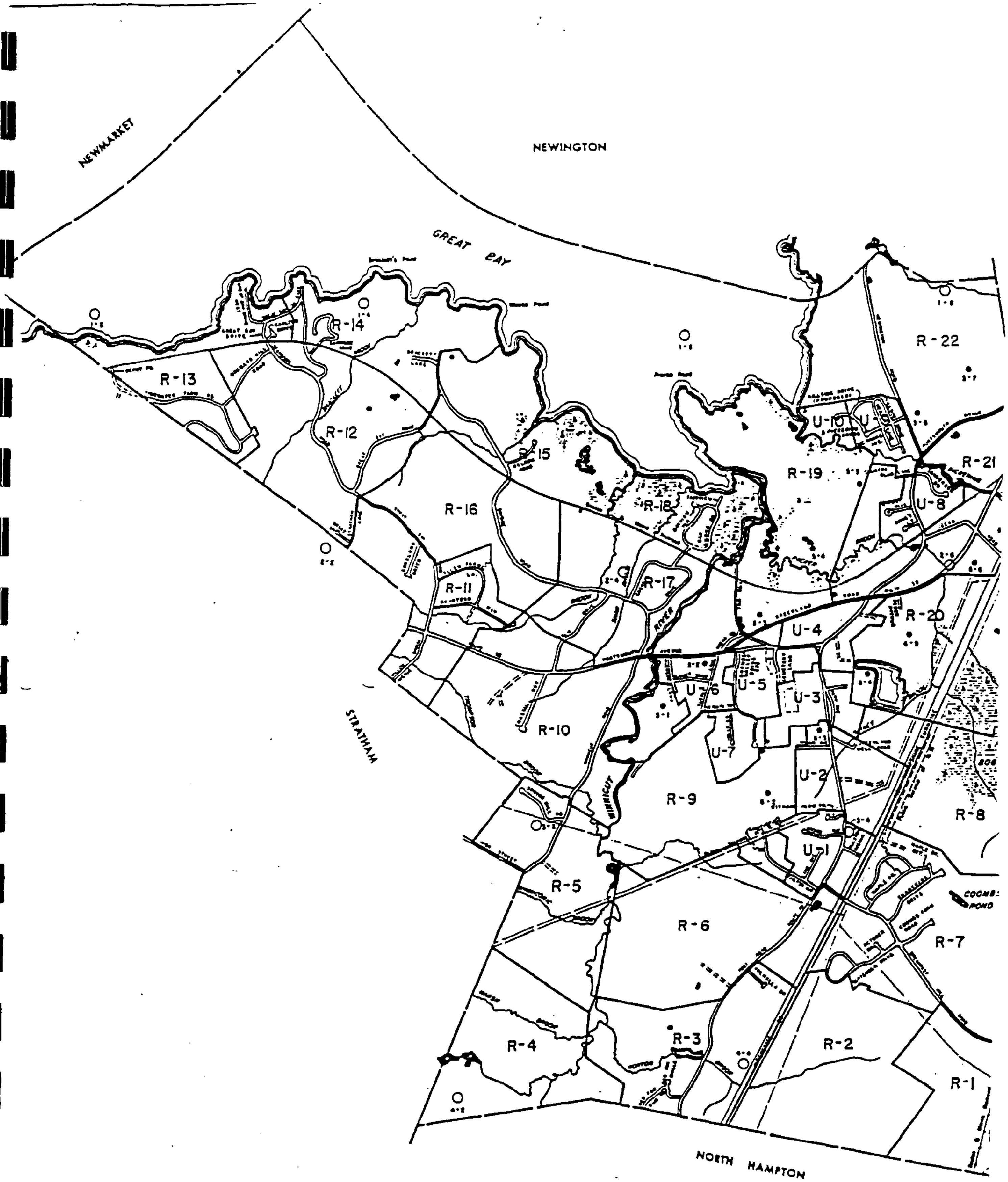
TOWN OF NEWFIELDS



MAPS UPDATED AUGUST 1993

INDEX MAP
TO
ASSESSORS PLANS
FOR THE TOWN OF
NEWINGTON
NEW HAMPSHIRE





PROPERTY MAP

GREENLAND

NEW HAMPSHIRE

INC

Appendix B

State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES
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May 19, 1995

Andrea Tomlinson
Jackson Estuarine Laboratory
85 Adams Point Road
Durham, NH 03824-3427

RE: Pitman Property, Newmarket, NH

Dear Ms. Tomlinson:

In response to your April 25 letter, a joint site inspection of the Pitman property was conducted on the morning of May 3, 1995, by DES personnel and the Town of Newmarket Health Officer. The property owner, Stanley Pitman, was present.

A luxuriant patch of grass was observed leading downslope from what may be a septic system, toward a freshwater pond. While this could be indicative of a failed septic system, no moisture or odor was discerned at time of our inspection. Hence, it could not be concluded at the time that a septic system was in a state of failure (reference: definition of septic system failure in RSA 485-A:2 IV.)

Inspection of the pond's shoreline revealed tunnels or burrows possibly made by muskrats or other warm-blooded animals. As such animals generate fecal coliform (as do ducks) we feel it is possible for wild life to be the source of the bacteria you encountered.

Mr. Pitman commented that his commercial septic system had been "corrected" some time ago. This may been by relocation since some old sewage piping was observed near the pond and if done since July 1, 1967, needed prior state approval. We do not find any approvals under Pitman.

We suggest that the area be reinspected from time to time by you, by the Town, and by DES with a view to determine whether or not any septic system is failing. Once failure can be determined, enforcement may be effected jointly by the Town of Newmarket and DES.

If you have any questions, please respond to the address shown for the Water Supply and Pollution Control Division.

Sincerely,

Kenneth J. MacDonald

Kenneth J. MacDonald
Subsurface Systems Bureau

KJM/drt
cc: Kenneth Sherwood, HO, Newmarket
Dennis Plante, DES

AIR RESOURCES DIV.
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Appendix C

Analysis of the Potential Impact on the Growing Area of a Contaminated Wastewater Plume Originating at the Durham WWTP

One of the areas identified as needing additional information following review of the Draft Great Bay Sanitary Survey was the potential effect of an upset, or release of non disinfected water from the Durham WWTP on the sanitary quality of Little Bay and Great Bay. To this end, the following documents were reviewed: a 1972 Masters Thesis from UNH entitled The Hydrography of the Oyster River Estuary; an extensive dataset accumulated over a two year period for nutrient concentrations in the Oyster River; a study conducted in 1994 on transport and dilution of nutrients from the Durham WWTP.

Of the documents reviewed, the most helpful was The Hydrography of the Oyster River Estuary. and most of the following analysis is based on the measurements, calculations and modeling conducted for that study.

Any particle released in the river at point x as the tide begins to ebb, will travel to a downriver point x1 before the tide reverses and causes the particle to travel in the opposite direction on the flood tide. Since the net seaward transport is the difference between the net inflow (calculated at 6 cm/sec) subtracted from the net outflow (calculated at 8 cm/sec), the particle will travel out of the estuary at a net speed of 2 cm/sec. As determined in the above referenced hydrographic study, total flushing time calculated for the Oyster River is 90 hours under low flow conditions, 80 hours under average flow conditions, and 50 hours under high flow conditions. Flushing time is defined as the the amount of time required for a slug of water originating at the head of the river (i.e. the Mill Pond Dam, a distance of 5 km from the mouth of the river) to be completely transported out of the mouth of the river. This definition takes into account vertical tidal mixing, with significant dilution occurring during each flood tide. If we were to consider a release of untreated sewage at the treatment plant, which is located approximately 3.3 kilometers from the mouth of the river and apply the same flushing rates, it would take 45 hours under average flow conditions before some of this water mass reached the mouth of the Oyster River. In 45 hours, this slug will have been diluted and dispersed by nearly four complete (high-low-high) tidal cycles. To look at it more conservatively, we can assume that there is no vertical mixing, and that the net seaward transport is 8 cm/sec rather than 2 cm/sec. Using this figure, a slug of untreated sewage would begin to reach the mouth of the Oyster River in 11.4 hours, or approximately one complete tidal cycle (high-low-high). Once at the mouth of the river at high slack tide, this water mass would follow ebb currents outward into Little Bay (toward the Sullivan Bridge). Net seaward transport has not been calculated for this section of the bay, however, we can assume that this water mass would make some progress outward before the tide reverses and carries the contaminated slug back toward the Oyster River mouth and, of course of interest to us, the portion of Little Bay included in our recent survey. It would therefore be another full tidal cycle before contaminated water could enter the survey area. By this time, (18-24 hours following the release of the untreated sewage) the slug of water will have been diluted by three flood tides. Based on the tidal prism in the Oyster River, and an average discharge volume of 2.55×10^4 m^3, the cumulative volume of the river at low tide was calculated to be 1.2×10^6 m3, and the high tide volume of 3.7×10^6 m3. In liters, these volumes translate to 1.2×10^9 and 3.7×10^9 Liters respectively, with a tidal prism of 1.5×10^9 liters. Daily average effluent volume in the Oyster River is ≈ 1.2 MGD of continuous flow. If untreated sewage were released for a four hour period, this would result in a release of .2 million gallons of untreated sewage. If we apply a theoretical concentration of 2 million fecal coliforms per 100 ml of effluent, the total release would amount to a release of 1.48×10^6 Liters with a concentration of 200,000 fecal coliforms per liter. This dilution factor for the first tidal cycle, if we assume mixing with only the amount of water contributed by the tidal prism, would be $1.5 \times 10^9 / 1.48 \times 10^6 = 1.01 \times 10^3$ or approximately a factor of 1000, resulting in a plume concentration of 200 fecal coliforms/liter. The plume will have traveled downriver from the plant a distance less than the total distance to the mouth of the river before the tide reverses, pushing the effluent plume back upriver towards the dam. The flooding tide would result in further mixing of the plume with another volume which is at minimum equal to the average tidal prism of 1.5×10^9 liters. If we assume that the concentration of the river water at low tide (before the flood tide begins) is 200 fc/liter, and the low tide volume of the river is 1.2×10^9, dilution and mixing of this volume would be greater than 2 to 1, (1.5 to 1.2), resulting in a concentration of 95 fc/liter or 950 fc/100ml. At this point in time (slack high tide) the plume

is now at the mouth of the Oyster River, continuing to mix with waters of Little Bay as it flows outward toward the General Sullivan Bridge. This area of Little Bay is characterized by turbulent mixing, resulting in a great deal of dilution of the plume as it travels in the ebb tide waters. The potential for portions of this now diluted plume affecting the growing area will depend on:
1) The contaminant concentration of the trailing edge of the plume on the falling tide as it exits the Oyster River
2) The amount of dilution of the plume in Little Bay and the amount of dilution of the plume by the tidal prism of the subsequent flood tide
3) The portion of the plume that is moved into the portion of Little Bay extending south from the Great Bay Sanitary Survey boundary line (Fox Point to the Southern Shore of the Oyster River)
4) The time between the turn of the tide (18 hours after the upset) and the time it takes for the plume to potentially impact the growing area. The minimum would be 18 hours following the upset, though it is more than likely between 20 and 24 hours.
5) The amount of additional dilution that the plume undergoes as it travels southward into the survey area in Little Bay

The answers to these questions may not be necessary at this point. A very conservative outlook was used estimating the time for the plume to reach the mouth of the river (11.5 hrs). The dilution of the plume as it travels through Little Bay (based on a estimate of the low tide volume in the section of Little Bay from the mouth of the Oyster River to Cedar Point is roughly 15 times the high tide volume of the Oyster River. Given the turbulent mixing in this area, the plume would be diluted 15 parts to 1 during the outgoing tide, resulting in a concentration of 63 fc/100 ml in when the tide begins to flood at hour 18. Given this scenario, and if no decay coefficient is applied to the bacteria, it is possible for some contamination (at the 63 fc/100 ml concentration) to reach the survey area 18 to 24 hours following an upset at the Durham WWTP. The concentration of the contaminant plume would therefore realistically be <63 fc/100 ml, and could potentially be less that the water quality standard of 14 fc/100ml. Recommendations for additional work are:
1) Research additional hydrographic information that may potentially be available from either Tom Ballestero at UNH or Mike Marsh at Region I EPA.
2) Request that Dr. Cellikol and Dr. Swift of UNH run a Wasp Model on the Oyster River
3) Run the CORMIX model (version 3.1) for a single port diffuser for the Oyster River

If all of these options fail to provide reliable answers, a dye release study could be conducted as part of the NEP project.

REFERENCES

Shanley, G.E. 1972. The Hydrography of the Oyster River Estuary. Master's Thesis, Department of Earth Sciences, University of New Hampshire. June, 1972.

Jones, S. H. and R. Langan. 1994. Land Use Impacts On Nonpoint Source Pollution In Coastal New Hampshire Watersheds. Final Report to the NH Coastal Program, NH Office of State Planning. July 1994.